(Re)Designing the System of Care for Neonates Suffering from Respiratory Distress Syndrome

Russian Federation - United States of America

2001

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The Health Committee

Access to Quality Health Care

Ministry Of Health
Russian Federation

Central Public Health
Research Institute (CPHRI)

Tver Oblast
Department of Health
Russian Federation

United States Department of
Health And Human Services

Agency for Health Research
and Quality (AHRQ)

The Quality Assurance Project

University Research Co., LLC
Center for Human Services

QUALITY ASSURANCE PROJECT

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The USA–Russia Joint Commission on Economic and Technological Cooperation

The Health Committee

"Access To Quality Health Care" Priority Area

(Re)Designing the System of Care for Neonates Suffering from Respiratory Distress Syndrome

Financed by the United States Agency

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Developed by:

Tver Oblast Health Care Department

Central Public Health Research Institute of

The Ministry of Health of the Russian Federation

Quality Assurance Project - University Research Co., LLC/

Center for Human Services, Bethesda, MD, USA

TVER OBLAST

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Preface

The work presented in this clinical guideline was conducted under the US-Russia Joint Commission on Economic and Technological Cooperation, Health Committee, Access to Quality Health Care priority area. The Russian partners in this collaboration included the Ministry of Health, Russian Federation, Central Public Health Research Institute (former MedSocEconomInform), and Tver Health Department. The US partners in this collaboration included the Agency for Health Care Policy and Research. The work was funded by USAID under contract to the Quality Assurance Project, implemented by University Research Corporation/Center for Human Services, Bethesda, MD, USA.

Clinical Problem:	Neonatal Respiratory Distress Syndrome (RDS)
Title of the Document:	Clinical Guideline for Neonatal Respiratory Distress Syndrome
Stages of Provision of Medical Care:	1. Maternity departments 2. Transportation of neonates 3. Neonatal intensive care center
Institutions using the protocol:	Children Oblast Clinical Hospital Children City Clinical Hospital #1 (Tver) Maternity Hospital #1 (Tver) Maternity Hospital (Vyshny Volochyok) Children City Clinical Hospital (Vyshny Volochyok) Maternity department (Torzhok)
Project Stage:	Phase II. Dissemination of Phase I
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2. Acronyms

ABB	Acid-Base Balance
BE	Base Deficiency
ABG	Arterial Blood Gas
BPD	Bronchopulmonary Dysplasia
C	Celsius
CBG	Capillary Blood Gas
CMV	Cytomegalovirus
CNS	Central Nervous System
CPAP	Continuous Positive Airway Pressure
CPHRI	Central Public Health Research Institute of the Ministry of Health of the Russian Federation
CVP	Central Venous Pressure
EGA	Estimated Gestational Age
ET	Endotracheal
ETCPAP	Endotracheal Continuous Positive Airway Pressure
FiO2	Fraction of Inspired Oxygen
HR	Heart Rate
HMD	Hyaline Membrane Disease
ICU	Intensive Care Unit
I:E Ratio	Inspiration: Expiration Ratio
IWL	Insensible Water Losses
MAP	Mean Aortic Pressure
NCPAP	Nasal Continuous Positive Airway Pressure
PaCO2	Partial Pressure of Carbon Dioxide in Arterial Blood
PAO2	Alveolar Partial Pressure (Tension) of Oxygen
PaO2	Arterial Partial Pressure (Tension) of Oxygen
PCO2	Partial Pressure of Carbon Dioxide in Capillary Blood
PDA	Patent Ductus Arteriosus
PEEP	Positive End-expiratory Pressure
PIP	Peak Inspiratory Pressure
PO2	Partial Pressure (Tension) of Oxygen
PPHN	Persistent Pulmonary Hypertension
PPV	Positive Pressure Ventilation
RD	Respiratory Distress
RDS	Respiratory Distress Syndrome
RR	Respiratory Rate
SaO2	Percentage Saturation of Hemoglobin in Arterial Blood
SpO2	Percentage Saturation of Hemoglobin measured transcutaneously.
TTNB	Transient Tachypnea of the newborn

3. Commonly Used Terms

Apgar Score – (V. Apgar was born in 1909, American anesthesiologist) is a way of objectively assessing a newborn's condition by scoring 5 clinical indicators, i.e. skin color, heart rate, respiratory effort, reflex irritability and muscle tone.

Bronchopulmonary Dysplasia (Chronic Lung Disease) – **(P27.1 ICD-10)** – a severe form of lung damage affecting neonates, more often pre-term infants, that some authors believe results from pulmonary oxygen toxicity as well as ventilator-induced injury.

Diaphragmatic eventration (weakness) – A condition of the diaphragm, which leads to the displacement of the abdominal organs towards the chest cavity, accompanied by pulmonary dysfunction.

Downe's scale – a Clinical Respiratory Distress scoring system identifying the critical nature of the newborn's condition as well as recommended actions.

Enteral feeding – feeding through digestive tract.

Noisy, "Groaning" expiration (Expiratory Grunts) – a maneuver whereby the infant breathes air out against a closed glottis, thus increasing intrathoracic pressure and increasing functional residual capacity.

Hypoglycemia – an abnormally low level of glucose in the blood.

Hyperthermia – a body condition characterized by abnormally high temperature.

Hypothermia – heat imbalance, accompanied by subnormal body temperature.

Initial neonatal resuscitation – the sum total of interventions and neonatal primary care provided in the delivery room to stabilize a newborn.

Fetal distress – this is indicated by the alternation of fetal activity and/or abnormal heart tones.

Neonatal Asphyxia (asphyxis neonatorum) – a lack of oxygen and an excess of carbon dioxide in the body usually caused by an interruption of gas exchange. The main characteristics of which are:

1. Profound metabolic or mixed acidemia (pH <7 of an umbilical cord blood sample)
2. Persistence of an Apgar score of £ 3 for > 5 min
3. Clinical neurological symptoms in the immediate neonatal period to include seizures, hypotonia, coma or hypoxic-ischemic encephalopathy
4. Manifestation of multiorgan system dysfunction of the immediate neonatal period

Oxygen Saturation – the percentage of blood hemoglobin oxygen saturation.

Parenteral feeding – feeding not through digestive tract.

Persistent Pulmonary Hypertension – a clinical condition affecting newborns that includes pulmonary hypertension, right to left shunting at the ductus arteriosus and foramen level, and a structurally normal heart.

Pulse oximetry – a method that measures blood oxygen saturation using a non-invasive monitoring device.

Respiratory Distress Syndrome – respiratory insufficiency manifested by severe respiratory distress caused by reduced surfactant content in the lungs due to its insufficient production or excessive inactivation.

Respiratory Insufficiency (Respiratory distress) – a pathologic condition of the body that fails to maintain normal blood gas values or maintains it by increased activity of auxiliary muscles. If the latter wears out or malfunctions hypoxia or hypercapnia may emerge.

Surfactant – a surface-active substance forming a monomolecular layer on the alveolar surface of the lungs stabilizing alveolar volume by decreasing surface tension and preventing alveolar collapse.

Wilson-Mikity Syndrome – a disease of unknown origin essentially leading to changes like bronchopulmonary dysplasia affecting pre-terms as well as term infants; quite uncommon and believed by some to be a variant of BPD.

4. Introduction

4.1. Background

This clinical guideline was developed as part of the demonstration projects in Quality Assurance. The clinical guideline describes the clinical and organizational aspects of health care delivery in the system of care for patients with RDS. However, it was neither developed nor implemented in isolation from the rest of the quality improvement process. The quality improvement process included:

- Planning the quality improvement project
- Designing the project set-up, including teams and participating facilities
- Training in Quality Assurance, development of team skills, and subject matter knowledge in RDS
- Development of an appropriate set of indicators to monitor the project
- Understanding the current system of health care in RDS
- Clarifying existing practices in RDS
- Developing the updated clinical guideline
- Enhancing the capacity of the system of care to enable the implementation of the updated clinical guideline in RDS
- Testing the new system of care for improvement and making further changes as necessary
- Monitoring the indicators of quality throughout the improvement process

It is important to point out that the authors' experience shows that the development of clinical guidelines on its own does not necessarily lead to improved quality. The whole process of quality improvement, as described above, allows the guidelines to be developed as well as implemented and tested for improvement. The authors recommend that in applying the clinical guidelines, special attention be paid to issues of adaptation, communication, and implementation of clinical guidelines in order to increase the chances of their successful implementation in everyday practice.

This document describes the clinical guideline developed in RDS. The content of the clinical guideline has been developed from the best available Evidence-Based Medicine at the time the work was conducted. The clinical guideline integrated clinical content as well as organizational, technological, and cultural aspects of health care delivery relevant to the setting in Tver Oblast.

4.2. Goals for Guideline Development

Table 4.1 Analysis of infant mortality in Tver Oblast for 1997 and 1998 per 1,000

Year	Still Birth Rate	Early Neonatal Mortality Rate	Neonatal Mortality Rate	Infant Mortality Rate
1997	18.8	8.9	11.9	18.4
1998	18.9	10.3	13.4	19.5

Table 4.2 Causes of early neonatal mortality rate in Tver Oblast (per 10,000)

Causes	1997	1998
Congenital developmental defects	19	25
RDS	20	35
Other prenatal conditions including:	63	61
- birth injury	9	8
- atelectasis	10	11
- asphyxia	15	13
- intrauterine pneumonia	14	10
- others (bleeding, hypoxia, deep prematurity, etc.)	15	19

In July 1998, a planning workshop was convened in Tver Oblast to decide on priority areas for improvement in maternal and child health. At this workshop, it was decided to embark on improving care for neonates suffering from Respiratory Distress Syndrome.

The objective for the development of this clinical guideline is to update and improve clinical practice in management of neonatal RDS.

The Clinical Guideline is designed to cater to all stages of the management of newborns with RDS starting from the moment of diagnosing RDS until full recovery.

The fundamental principles upon which this guideline was developed are Evidence-Based Medicine, current technical and financial resources of health care in Tver Oblast.

4.3. Guideline Development Methodology

Methodology for the Development of the Clinical Guideline

A key requirement of the collaborators was the use of Evidence-Based Medicine as the basis for the clinical guideline development. References, articles, and other sources of information used in the development of the clinical guideline were screened for the level of evidence supporting them. Content experts involved in the work were requested to pay special attention to the evidence-based content of each resource. This issue is particularly relevant to the Russian health care system after many years of isolation from international medical research. Hence, the Russian Ministry of Health is paying special attention to the dissemination of Evidence-Based Medicine and to its use in practice.

The model for the work is based on Paul Batalden's Framework for the Continual Improvement of Health Care[1] . This framework suggests the integration of subject matter knowledge with improvement knowledge as a powerful means of continual improvement in health care. The guideline was developed as an integral part of the quality improvement project. The principles of a systems approach, teamwork, customer focus, and scientific methodology used in the process improvement project, were also applied to developing the clinical guideline. Based on this framework and the principles of quality management, Dr. Rashad Massoud of the QAP/URC-CHS developed the methodology for clinical guideline development used in this work. The key steps in this methodology consist of the following:

1. Study the existing system of health care delivery.

The organization of the system or process of care is reviewed by a team of professionals involved in the given process of health care delivery. Members of the team should have between them all the necessary insights into this process of care. The team discusses their understanding of the process of care. By the end of this step, they draw a detailed flowchart or series of flowcharts to illustrate how the process of health care delivery is currently taking place.

2. At each step in the process of health care delivery, make explicit what, if any, clinical content is involved.

The team goes through the process of health care delivery and at each relevant step in this process makes explicit what clinical content pertains to this step. The clinical content can be in many forms: clinical definitions, criteria for diagnoses, criteria for referral, various clinical decision-making steps made explicit, treatment guidelines, etc. Most of these would be difficult to write down onto the flowchart simply for lack of space. It is suggested that this clinical content information be included as appendices that can be linked to specific steps in the process. The links to the main text can be made either by numbers and signs or by arranging the clinical content to follow the steps in the flowcharts. For those steps where it is not possible to agree on the clinical information, either because it is not available or because different professionals use different criteria, it is important to make notes to this effect.

[1] *Paul B. Batalden, MD, Patricia K. Stoltz, PA-C, A Framework for the Continual Improvement Knowledge to Test Changes in Daily Work, Journal of the Joint Commission on Quality Improvement, October 1993*

3. Review Evidence-Based Medicine literature on the subject matter of the clinical guideline.

A literature review is made and Evidence-Based Medicine materials are prepared for a seminar at which the subject matter for the clinical guideline is analyzed. This material is then delivered at the seminar, starting from definitions and basic understandings moving to the latest evidence-based materials on the subject matter. A team of high-level experts in the subject matter led this part of the development of the clinical guideline. In this case, the team included experts from the USA and Russia. Quality Assurance experts also provide support to the content experts regarding the process of clinical guideline development as well as the process of linking the clinical and organizational aspects of the new system of care.

4. Update the clinical content in accordance with the Evidence-Based Medicine knowledge of the subject matter.

The project team returns to the current systems and processes and reviews them in the light of the clinical update discussed at the seminar. The objective of this step is to decide what clinical content needs to be changed or updated in order to make their new systems compatible with the state-of-the-art in the given clinical care. The first decisions to be made pertain to what parts of the clinical content need to be changed. Changes in clinical content are discussed and reviewed in light of their understanding of the reality of the health care system. This is perhaps the most difficult part of the work, as it entails changes in physicians' practices of clinical medicine. For this reason, including the key stakeholders on the team is essential. The team must also include the professionals who will be responsible for ensuring that the changes in clinical practice will be implemented. Therefore the teams need to include the senior physicians, as well as general practitioners involved in the everyday delivery of health care and other clinical staff including nurses and midwives. The team decides on which issues need to be changed in the current clinical practices.

5. Introduce changes to the system of care to enable the implementation of the updated content knowledge.

As clinical changes are discussed, the organization of care is reviewed simultaneously, and changes in the organization of care are also considered. The objective of the exercise is to change the existing system such that it will enable the implementation of the updated clinical content. This may seem straightforward on the surface. However, in reality, to what extent the team is able to decide on what can and cannot be changed in the system of health care delivery is a far more complex set of decisions. Discussions and negotiations between the members of the team and the leadership are required for this purpose. By the end of this stage, new flowcharts are developed with accompanying appendices describing the updated clinical content.

6. Review the indicators to ensure that they reflect the changes in both subject matter knowledge and changes in the system of care.

The clinical guidelines, as well as other components of the work, are implemented as an integral part of the process improvement. One such component is the development of quality indicators, a set of measurements which allows us to monitor the progress of the improvement project at the process, outputs, and outcomes levels. The indicators are set up prior to the development of the updated clinical guidelines. However, the indicators need to be reviewed once the new clinical guideline and system of care are decided on so that they reflect important changes in the new system of care and its clinical content.

4.4. Scope of Application and Purpose of the Guideline

The purpose of this clinical guideline is to improve medical care and streamline the organization of different stages of medical care delivery starting from basic institutions and up to Oblast institutions and centers. Special attention is also given to the diagnosis of RDS and to the specific care for newborns diagnosed with RDS.

4.4.1. Clinical Description of Guideline Contents

Differences in RD and RDS definitions

Please note the difference between Respiratory Distress Syndrome (RDS) and respiratory distress. Respiratory distress or respiratory insufficiency is a symptom of any number of causes including RDS. It is a pathologic condition of the body that fails to maintain normal blood gas values or maintains it by increased activity of auxiliary muscles. If the latter wears out or malfunctions hypoxia or hypercapnia may emerge.

RDS is respiratory insufficiency manifested by severe respiratory distress caused by reduced surfactant content in the lungs due to its insufficient production or excessive inactivation.

RDS Predisposing Factors

1. Prematurity
2. Cesarean section without labor
3. Severe perinatal asphyxia
4. Maternal diabetes
5. Maternal bleeding
6. Male greater than female
7. Second-born twin
8. Rh-erythroblastosis

Causes of Respiratory Distress in the Newborn

A. Pulmonary

1. Hyaline Membrane Disease (HMD) or Respiratory Distress Syndrome (RDS)
2. Transient tachyphea of the newborn (TTNB)
3. Aspiration of meconium, blood, amniotic fluid, gastric content, milk
4. Pulmonary hemorrhage
5. Pneumonia
6. Persistent Pulmonary Hypertension of the Newborn (PPHN)
7. Chronic Lung Disease or Bronchopulmonary Dysplasia (BPD)
8. Congenital malformation of the upper airways and lungs, i.e. choanal atresia, hypoplasia/ aplasia of lung(s), lobar emphysema
9. Atelectasis
10. Pleural effusion
11. Wilson-Mikity Syndrome (rare)

B. Extra – Pulmonary

1. Cardiac:
   Right ventricle heart failure
   Hemodynamically significant ductus arteriosus (PDA)
   Congenital heart disease
2. Neurologic:
   Hypoxic-ischemic encephalopathy
3. Hematologic:
   Acute blood loss
   Hypovolemia
   Twin – twin transfusion
   Polycythemia
4. Metabolic:
   Acidosis
   Hypoglycemia
   Hypothermia
   Congenital hyperthyroidism
5. Infection:
   Sepsis
   Meningitis
6. Gastrointestinal:
   Diaphragmatic hernia
   TE fistula with aspiration
   Abdominal distension
   Diaphragmatic paralysis or eventration

Major Symptoms of RD and Their Interpretation

1. **Tachypnea (RR>60/min)**
   Increased RR normally indicates inadequate oxygenation or ventilation. Tachypnea results from reduced PaO_2 or increased pCO_2 in blood.

2. **Cyanosis**
   Cyanosis reflects unsaturated hemoglobin content in neonate's blood, normally greater than 30-50 g/l. It may accompany heart diseases, respiratory and central nervous system diseases and metabolism imbalance.

3. **Auxiliary muscles**
   Increased activity may occur in any muscle (group of muscles), functionally connected with the rib cage, i.e. intercostal, subclavicular, intracostal. It indicates considerable pulmonary insufficiency, which a neonate tries to compensate for by using all available groups of muscles to maximize ventilation. It is especially typical for diseases accompanied by reduced alveolar ventilation, primarily due to atelectasis.

4. **Noisy, "Groaning" Expiration (Grunts)**
   Audible sounds at the end of expiration resulting from airflow through partially narrowed glottis. It is an unconscious effort a neonate makes to increase lung volume at the expiration to prolong alveolar gas exchange. This symptom is common for RDS, however, it may occur in the case of any other disease accompanied by reduced alveolar volume.

5. **Apnea**
   Respiratory pause duration more than 15 seconds or less than 15 seconds if it is accompanied by bradycardia less than 100/min. Despite the fact that apnea is a regular symptom for the majority of pre-terms, its emergence within 24-28 hours usually indicates grave disease.

6. **Nasal flaring**
   Nasal flaring during inspiration indicates increased respiratory efforts and often suggests early RDS symptoms.

7. **Reduced Motor activity**
   Reduced activity is often not acknowledged as a symptom of RDS, since reduced activity is a nonspecific symptom, which can accompany sepsis and CNS disorders. However, it should be evaluated in the context of the signs and symptoms as it does accompany RDS. In general, neonates with severe lung disorder will have depressed function except for respiration.

Differential Diagnosis

Other causes of respiratory distress such as metabolic, cardiac and hematological conditions must be considered.

Principles of Management of RDS

Supportive Treatment

1. Maintain normal body temperature
2. Different methods of oxygen therapy depending on the severity starting from incubator, oxygen hood, CPAP and ventilator
3. Maintain hydration and electrolytic balance and correct acid base balance
4. Maintain hemodynamics
5. Maintain normal hematocrit and hemoglobin
6. Monitor hemoglobin oxygen saturation
7. Antibacterial therapy

Surfactant Therapy

Difficulty in manually ventilating, poor chest expansion, and persistent cyanosis are indications for early administration of Surfactant.

1. Surfactant Administration: administered without regard to birth weight, but usually after the following criteria are met:
   - Clinical and radiographic confirmation of RDS
   - $PaO_2 < 80$ mm Hg in $\geq 30\%$ oxygen
2. Retreatment: Up to four doses of Surfactant every 6 hours (but within 48 hours after birth), may be given if PaO_2 remains <80 mm Hg in >30% oxygen. Remember that if the infant is on PIP/PEEP of 18-20/4-5, one may be able to wean FiO_2, to < 30 % in mild HMD. Therefore, Surfactant retreatment must be reconsidered if PIP and PEEP cannot be reduced. It is also suggested that at least 2 doses of Surfactant be administered to very tiny infants even if they do not require oxygen after the first dose but require PIP/PEEP of more than 14/3.

3. Dose: Survanta - 4 ml/kg/dose;
   Exosurf -5ml/kg/dose
4. Administration: Surfactant should be administered under sterile precautions and only after the infant is clinically stable.
   - Surfactant: administered intratracheally by instillation through the side port of the ET tube adapter
   - Each dose is divided into two half doses and the first half dose is administered while the infant is lying supine.
   - The infant is then turned to one side for 30 seconds, returned to the supine position,
   - Then the infant is given the remaining half dose and then turned towards the other side for 30 seconds.
   - The infant is then returned back to the supine position.
   - No suction within 1 hour after surfactant administration
   - Reduce ventilator settings to the baseline or lower if required
   - The infant should be ventilated mechanically.
5. Effects of surfactant therapy include improved oxygenation, reduced air leaks, and reduced mortality from RDS. Improved oxygenation is often seen immediately. Very close monitoring of FiO_2 and MAP is required because if the compliance improves abruptly, the high airway pressure may cause an air leak.
6. Surfactant Non-responders
   - Host-related factors: pulmonary edema, pneumonia, hypoplastic lung, meconium pneumonia,cyanotic heart disease, shock
   - Surfactant related factors: low or too high dose, quality of Surfactant, date of administration, method of administration
   - Management related factors: excessive hydration, too low or too high intravascular volumes, ventilator management, too low or too high pressures

Complications of ventilation

1. Infection, i.e. pneumonia, sepsis
2. Air leak syndrome, i.e. pneumothorax, pneumomediastinum, pulmonary interstitial emphysema
3. Complications related to tracheal intubation, tube shift, occlusion, atelectasis after extubation, mucous membrane lesion (decubital sore)
4. Tracheal lesion, i.e. erosion, granuloma, stenosis, necrotizing tracheobronchitis
5. Hemodynamic disorder
6. Chronic Lung Disease, i.e. bronchopulmonary dysplasia
7. Others, i.e. intracranial hemorrhage, retinopathy of prematurity

Prevention

Antenatal steroids reduce mortality, RDS.

Recommendations for Antenatal Steroid Treatment

1. All pregnant women between 23 and 35 weeks EGA should be considered eligible for steroid therapy.
2. Treatment should be limited to no more than 2 courses of steroid therapy at least 7 days apart. There must be one week between courses.
3. Medication/Dosage/course: Dexamethasone - 6.0 mg IM q l2h for 4 doses. One course may suffice.

4.4.2. Target groups

This guideline is intended for use for newborns with RDS. It should also be used for newborns with RD suspected to be due to RDS at all stages of health care delivery, i.e. maternity word, maternity hospital ICU, transportation to the neonatal center and neonatal center.

4.4.3. Guideline users

This guideline is designed for maternity department and children hospital neonatologists, central district

hospital general resuscitators, mobile resuscitation team and neonatal centers.

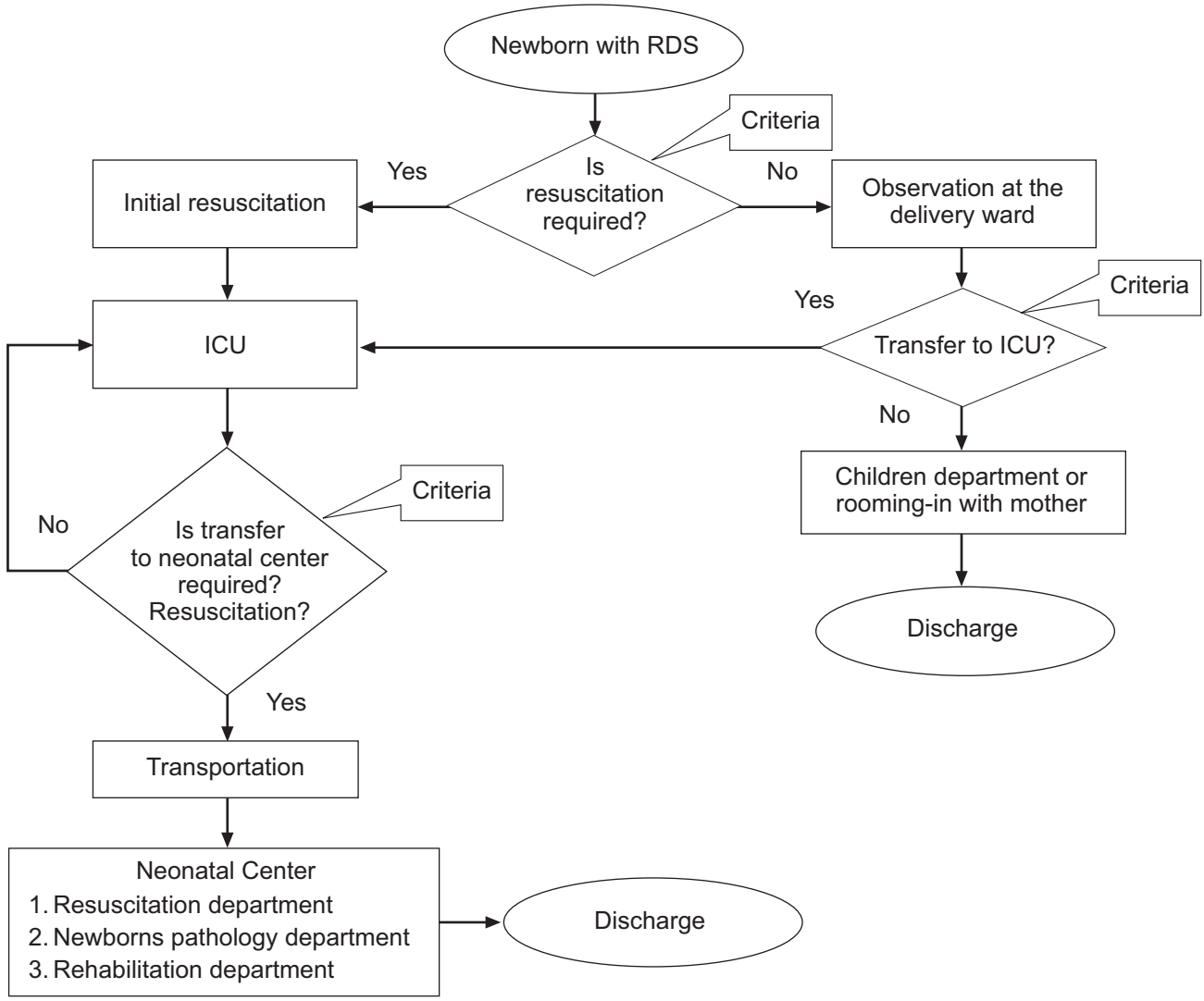
4.4.4. Expected outcomes

- A unified technological approach to manage neonates with respiratory diseases
- Drop in early neonatal and neonatal mortality in Tver Oblast
- Improved quality health care for neonates with respiratory diseases, especially for neonates from the Oblast districts
- A unified information system for medical care delivery to neonates with respiratory diseases
- Personnel training for the methods of continuous improvement of neonatal health care
- A unified understanding of quality medical care among all staff members

5. System of Care for Neonates with RDS

5.1. Flowchart for the Process of Health Care Delivery to Neonates with RDS

Fig. 5.1. Flowchart for the process health care delivery to neonates with RDS



5.2. Description of the Process of Care

According to the guideline medical care delivery may be presented in the following consecutive phases:

1. Maternity department
   - 1.1. Provision of initial resuscitation activities in a delivery room
   - 1.2. Observation of the newborn and treatment at the neonatal department
2. Transportation of the neonate to the neonatal center
3. Neonatal center

5.3. Provision for the Process of Health Care Delivery

5.3.1. Personnel

RDS Care: OB/GYN, midwife, pediatric nurse, neonatologist on site, ICU

Mobile team; neonatologist, resuscitator, pediatric nurse, driver.

Neonatal center personnel: neonatologists in charge of resuscitation, neurologist, neonatologists, physicians-consultants (surgeon, ophthalmologist, otorhinolaryngologists, orthopedist, rontgenologist), medical nurses, laboratory technicians and junior medical personnel.

5.3.2. Medications needed

Table 5.1 Medications

Medication	Delivery Ward	ICU	Transportation	Neonatal Center
Oxygen	+	+	+	+
Adrenaline	+	+	+	+
Sodium Bicarbonate solution 4%	+	+	+	+
Sodium Chloride solution 0.9%	+	+	+	+
5% Albumin solution	+	+	+	+
5-10% Glucose solution	-	+	+	+
Amino acids	-	-	-	+
Fat emulsion	-	-	-	+
10% Calcium Gluconate solution	-	+	+	+
7.5%/4% Potassium Chloride solution	-	-	-	+
Blood Preparations (erythrocyte mass, plasma)	-	+	+	+
Atropine	-	-	+	+
Heparin	-	+	+	+
Dopamine	-	+	+	+
Dobutamine	-	-	-	+

Table 5.1 Medications *(continued)*

Medication	Delivery Ward	ICU	Transportation	Neonatal Center
Hydrocortisone	-	-	+	+
Dexamethasone	-	-	+	+
Diazepam	-	+	+	+
Sodium Oxybutarate	-	+	+	+
Promedol (analgesic)	-	-	+	+
Vikasoli (Vitamin K)	-	+	+	+
Lasix (Furosemide)	-	+	+	+
Fentanyl	-	-	-	+
Arduan (Listenon)	-	-	-	+
Vitamins	-	-	-	+
C	-	-	-	+
B	-	-	-	+
E	-	-	-	+
Antibiotics	-	+	+	+
Penicillin group	-	+	+	+
3-4 generation				
Cephalosporin group	-	-	-	+
Aminoglucozid group	-	+	+	+
Surfactant replacing drugs			+/-	+

\+ *Essential* - *Not needed* +/- *Can be used but not essential*

5.3.3. Equipment Used in the Process of Health Care Delivery

Table 5.2. Equipment Used in the Process of Health Care Delivery

Equipment	Maternity Room	ICU	Transportation	Neonatal Center
Radiant heater	+	+	-	+
Oxygen Delivery System	+	+	+	+
Oxygen supply source (oxygen cylinder, oxygen container)	+	+	+	+
Blender	+	+	+	+
Rotary dosimeter	+	+	+	+
Portable emergency care kit: (laryngoscope with a set of size “0” and “1” blades, stylet, AMBU type bag with reservoir, manometers for measuring airway pressure during ventilation, connectors, endotracheal tubes, and suction apparatus for oro and nasopharynx suction)	+	-	+	-
Portable case with medications, infusion solutions, instruments, disposable syringes, needles	+	-	+	-
Oxygen masks	+	+	+	+
Oxygen tubes	+	+	+	+
AMBU type bag	+	+	+	+
Oxygen hood	-	+	-	+
Humidifier	-	+	-	+
Ventilator	+/-	+/-	+	+
Oxygen analyzer	+	+	+	+
Incubator	+	+	-	+
Mobile incubator	-	-	+	-
Pulse oxymeter	-	+	+	+
Gas analyzer	-	-	-	+
Electrolytes analyzer	-	-	-	+
Polyfunctional monitor	-	+	+	+

Table 5.2. Equipment Used in the Process of Health Care Delivery *(continued)*

Equipment	Maternity Room	ICU	Transportation	Neonatal Center
Glucotest	-	+	+	+
BP measuring device with a set of cuffs	+	+	+	+
Microperfuser	-	+	+	+
Electrical thermometer	+	+	+	+
Pumps	+	+	+	+
Stethoscope	+	+	+	+
Supplies				
Intubation tubes & stylets	+	+	+	+
Umbilical catheters	+	+	+	+
Subclavian catheters	-	-	+	+
CPAP cannulas	-	+	+	+
Gastric tube	+	+	+	+
Disposable needles	+	+	+	+
Disposable syringes	+	+	+	+
Disposable infusion systems	-	+	+	+
Diapers	-	+	+	+
Mittens, socks, caps, blankets	-	+	+	+
Vehicle	-	-	+	-

\+ *Essential* - *Not needed* +/- *Can be used but not essential*

6. Stages of Medical Care Provision

Health care institutions providing medical care to newborns should have adequate medical equipment and supplies for diagnosis of RDS and concomitant pathology and subsequent pathology treatment (from the beginning of the treatment until an ICU team arrives) to successfully achieve objectives.

6.1. Initial emergency care for newborns in a delivery ward (Directive #372)

Any member of the team present at the moment of childbirth (OB/GYN, neonatologist, midwife, pediatric nurse) performs oro and nasopharynx suction when head is delivered.

6.1.1. Equipment needed in a delivery ward (to be used by a neonatal team)

1. Oxygen supply system (oxygen container, blender, oxygen mask or intranasal catheter)
2. Portable emergency care kit (laryngoscope with a set of size “0” and “1” blades, stylet, AMBU type bag with reservoir, manometers for measuring airway pressure during ventilation, connectors, endotracheal tubes, and suction apparatus for oro and nasopharynx suction)
3. Portable case with medications, infusion solutions, instruments, disposable syringes and needles
4. Radiant heater
5. Electrosuction with a set of catheters

6.1.2. Actions taken routinely including when amniotic fluid is lightly stained with meconium

1. Register baby’s time of birth when infant is delivered, start the Apgar clock timer
2. Put the baby under a radiant heater after the umbilical cord is cut and tied
3. Dry the baby with a warm cloth
4. Change the wet diaper/cloth for a warm and dry one
5. Put the baby on the back with a roll beneath its shoulders and its head slightly tilted backwards
6. Suction oral cavity first then nose
7. Provide tactile stimulation to the soles of the feet and rubbing the back.
8. In the absence of breathing or poor respiratory effort provide mask ventilation

6.1.3. Actions taken when amniotic fluid has thick meconium

1. Suction oral cavity and nasal passages as soon as its head appears (obstetrician)
2. Register baby’s time of birth, start the Apgar clock
3. Put the baby under a radiant heater on his back
4. Place a roll beneath his shoulders and the head slightly tilted backwards
5. Conduct direct laryngoscopy. Aspirate the trachea by connecting aspirator to the pump within 3-5 seconds and withdrawing the ET tube. If the ET tube is not available – use catheter with the proper diameter, i.e. French #10 or higher with 3 mm inner diameter.
6. After tracheal intubation and tracheal meconium aspiration are completed, intubation and aspiration are repeated if necessary. In general, more than three attempts are not warranted but suctioning through the ET tube may be continued if necessary.
7. Dry the baby with a warm cloth and remove the wet diaper
8. Suction stomach contents only *after infant is stable* (usually after 3-5 min.)

6.1.4. Intubation

Endotracheal intubation with direct laryngoscopy requires training, practice and experience. It should be accomplished rapidly by a skilled person with previous experience with newborns.

Indications

1. Bradycardia without improvement after 30-60 seconds of positive pressure ventilation with bag and mask
2. Continued Apnea
3. Inadequate air entry on bagging with mask or failure to expand chest, particularly after ensuring tight seal of the face mask
4. Any question of laryngeal anomalies which obstruct air exchange
5. Diaphragmatic hernia requiring resuscitation

Table 6.1. Endotracheal tube size

Baby's Weight (gm)	Diameter (mm)	Tip to Lip Distance (cm)	Tube Length
1000	2.5	7.0	11
1000-2000	3.0	7. -8.0	12
2000-3000	3.5	8.-9.0	13
3000-4000	3.5-4.0	9-10	14
>4000	3.5-4.0	10	14

Recommended position of tube:
Formula used: Wt (kg) + 6 cm = distance from tip to lip

Procedure

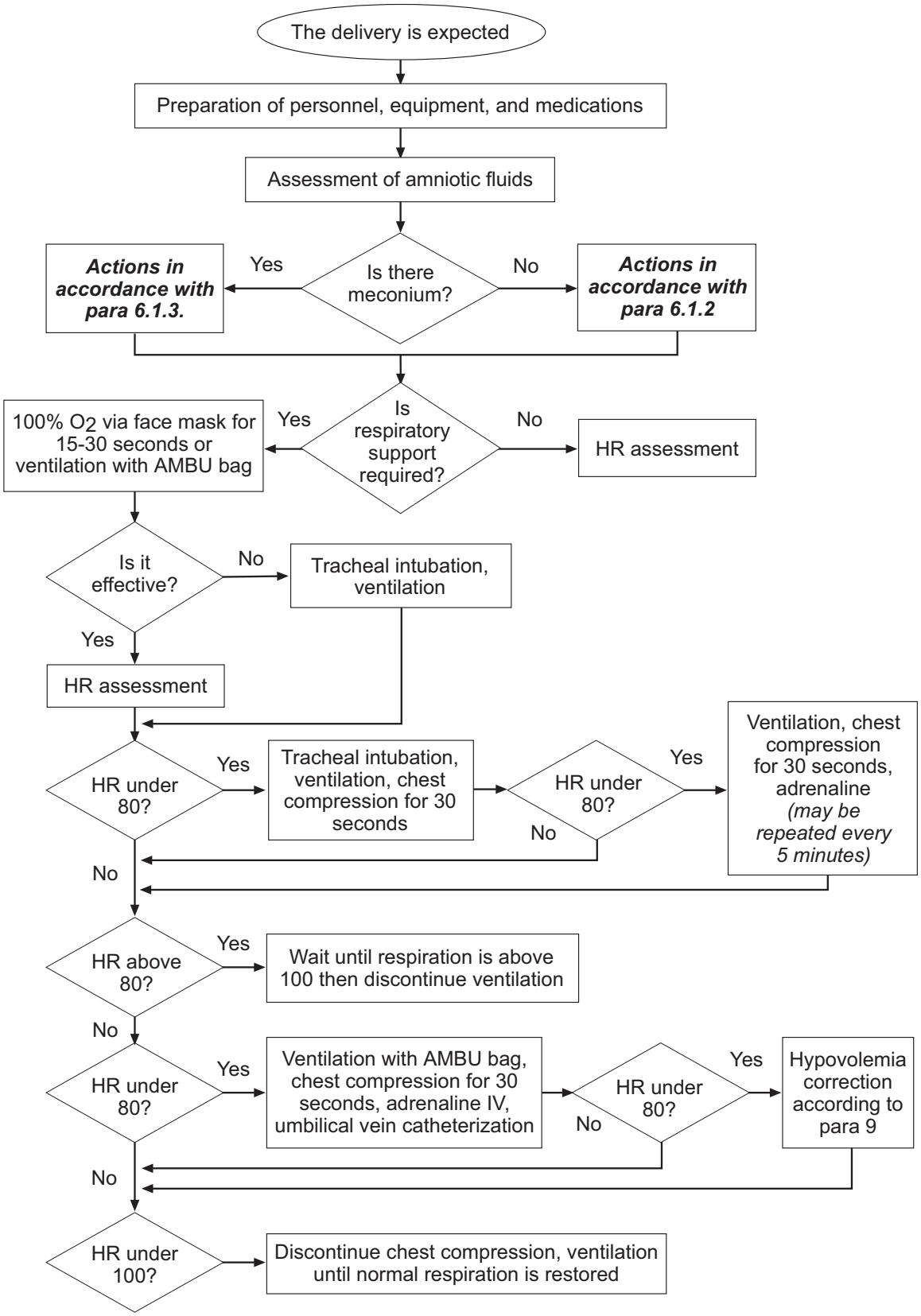
1. Stabilize patient
   - 1.1. Suction mouth and nose
   - 1.2. Bag and mask ventilate with 100% oxygen until the actual act of intubation
   - 1.3. Always provide blow by oxygen during intubation attempts
2. The baby is in the supine position with its head slightly extended (shoulders resting on a small roll or towel)
3. Laryngoscopy:
   - 3.1. Laryngoscope is used in the left hand only: hold with thumb, 1st and 2nd fingers at an angle.
   - 3.2. Introduce into the right side of the infant's mouth usually as far as it will go and move the blade to the midline to push the tongue to the left; lift the total laryngoscope up and forwards and look; the tongue will fall off to the left as you pull up.
   - 3.3. Unless you see the vocal cords, it is not the trachea.
   - 3.4. If the light is good, you will see the rings of the trachea. If not far enough, you will see the epiglottis in front of the trachea; get behind it and lift up. Trachea will drop down into view. Gentle external pressure on the larynx with your little finger may be helpful.
   - 3.5. Suction if there are secretions, etc.
   - 3.6. Introduce the ET tube along the right side of the infant's mouth, not along the groove of the laryngoscope blade. The groove is for visualization. Slide the tip of the tube through the vocal cords up to the black mark a few cm from the tip. Carefully withdraw the laryngoscope so as not to displace the tube. If the infants cry is heard, the tube is not in.
   - 3.7. Listen for breath sounds in the axillae.
   - 3.8. Fix tube to upper lip using tape.
   - 3.9. Recheck breath sounds.
   - 3.10. During bagging take care to ensure the tube is not bent or pinched.

6.1.5. Assessment of Baby's Condition after Birth

Table 6.2. Assessment of Baby's Condition after Birth

Assessment of Respiration	Assessment of Cardiac Rate	Assessment of Skin	Actions
Spontaneous, regular	Cardiac rate is over 100	Pink	Observation
Spontaneous, regular	Cardiac rate is over 100	Cyanotic	Oxygen is given by a mask under observation
None or inadequate	Assessment as a follow up measure		Suction oral cavity & nasal passages. Positive pressure ventilation (PPV) with an AMBU bag; via face mask for 15-30 seconds with 100% oxygen (rate of 40-60 per min & pressure of 30-40 H_2O first few breaths then 15-20 cm H_2O). After 2 minutes of bagging, insert nasogastric tube.
	Cardiac rate is over 80		Continue PPV until heart rate >100/min, regular spontaneous respiration is achieved, then discontinue ventilation, give oxygen through mask or intubation.
	Cardiac rate is under 80		Continue ventilation and chest compressions for 30 seconds
	Cardiac rate is under 80		Tracheal intubation, PPV with an AMBU bag, chest compressions, adrenaline (1:10000) endotracheally 0.1-0.3 ml/kg. May repeat every 5 minutes.Dose is 0.01-0.03mg/kg
	Cardiac rate is over 80		Discontinue chest compression, continue ventilation until regular respiration is achieved
	Cardiac rate is under 80		PPV with an AMBU bag, chest compressions, umbilical vein catheterization, adrenaline (1:10000) IV 0.1-0.3 ml/kg. May be repeated every 5 minutes.
	Cardiac rate is under 80		Sodium bicarbonate 4% - 4 ml/kg (2meQ/kg) over 2 minutes. Sodium chloride isotonic solution IV, lactated ringer's, or albumin 5% (10 ml/kg) is given over 15 – 30 minutes if there are signs of hypovolemia.
If there is no heartbeat within first 20 minutes after birth with adequate resuscitation, resuscitation is discontinued.			
If heartbeat is restored and respiration is absent or inadequate, the baby is manually ventilated until mechanical ventilation is available at neonatal center.			

6.1.6. Flowchart for Initial Resuscitation



6.2. Neonatal Department

Upon completion of initial resuscitation activities, babies from a high-risk group are transferred from a delivery ward directly to an intensive observation post or Neonatal department.

6.2.1. The following categories of newborns are also transferred to Neonatal department

1. Term infants with respiratory distress
2. Premature (less than 35 weeks gestation)
3. Babies who underwent resuscitation therapy at the delivery ward
4. Babies whose condition became complicated in early neonatal period
5. Babies with congenital malformation
6. Babies with nervous system lesions
7. If there is no neonatal department in a delivery department and there is a baby with the indicated problems, then an intensive observation post is created in a room where it is possible to provide continuous oxygen therapy and observation by medical personnel. Equipment (see below)

6.2.2. Objectives of This Phase

1. Continuous observation of a newborn by medical personnel: neonatologist and nurse observe the newborn for 24 hours a day and document vital signs in a hourly monitoring chart (see Appendix #1)
2. Hourly assessment of respiratory distress severity until 3 successive “0” scores according to the Downe’s scale
3. Maintenance of normal temperature
4. Correction and prevention of postnatal hypoxia
5. Infusion therapy
6. Laboratory investigations of major indications (Total blood count, blood sugar)

Incubator, radiant heater, oxygen, O_2 saturation monitor, multifunctional monitor should be readily available for admission into Neonatal department.

6.2.3. Maintenance of normal temperature

The objective is to maintain environmental temperature at a level, when metabolic processes require less energy. This temperature depends on the baby’s body weight, postnatal age, and possible sources of heat loss. The problem is solved by using incubators and outside radiant heaters. Measuring skin temperature by means of using a monitor or checking axillary temperature every 4-6 hours controls the temperature. Temperature should be checked every 15-20 minutes until stable. Normal body temperature for a newborn is 36.5-37.2^0 Celsius. Additional measures to preserve heat are the use of caps; socks, warm diapers and mattresses in incubators; careful drying of infants; avoidance of unnecessary handling of infants; and maintenance of room temperature up to 24-28^{0}C. The baby may be removed from the incubator when he/she can maintain constant body temperature and the room temperature is below 30°C.

6.2.4. Respiratory insufficiency treatment

General Rules

Determination of the need for respiratory therapy is made on the basis of clinical examination of the newborn’s condition, noninvasive methods of pulse oximetry or invasive measurement of blood gases and acid base balance (ABB).

Pulse Oximetry

This method is used to measure blood oxygen saturation (SaO_2), i.e. amount of oxygen carried by hemoglobin. Oxygen saturation depends on the oxy-hemoglobin dissociation curve. This method is satisfactory in most circumstances except with severe anemia or when there is methemoglobinemia or other aberrations. Fetal hemoglobin, hypothermia, and acidosis/alkalosis also shift the curve and alter values. Inaccurate measurements are observed in shock because of poor perfusion. This method does not allow having exact correlation between PaO_2 and SaO_2 for hyperoxia: 98-100% saturation may indicate a PaO_2 of 100 mm Hg as well as 300 mm Hg. In general for the newborn, a saturation of 90% suggests that the PaO_2 maybe ~ 50 mm Hg and a saturation of 94% indicates ~ PaO_2 of 60 mm Hg.

Pulse oximetry is a non-invasive monitoring method that measures arterial blood oxygenation using a photosensor. Red light source is placed on the pulse site with the counter being placed on the opposite side. The light coming through tissues is absorbed by saturated hemoglobin

Advantages

- ✥ long-term monitoring
- ✥ non-invasive method
- ✥ does not require calibration and warming up
- ✥ possible to monitor oxygen therapy in cases when blood gases monitoring is not available
- ✥ complications were not reported
- ✥ RR monitoring is possible

Disadvantages

- ✥ inaccurate measurements in case of poor tissue perfusion
- ✥ alarm often turns on when the baby moves
- ✥ additional light sources in the room, photo lamp may distort saturation values

Procedure

- ✥ make sure the sensor is placed on the pulse site
- ✥ make sure the light source and sensor are placed opposite to each other
- ✥ set alarm at 90-95%
- ✥ carefully document measurements especially when taking blood gases
- ✥ change sensor's position every 4 hrs. to prevent pressure damage

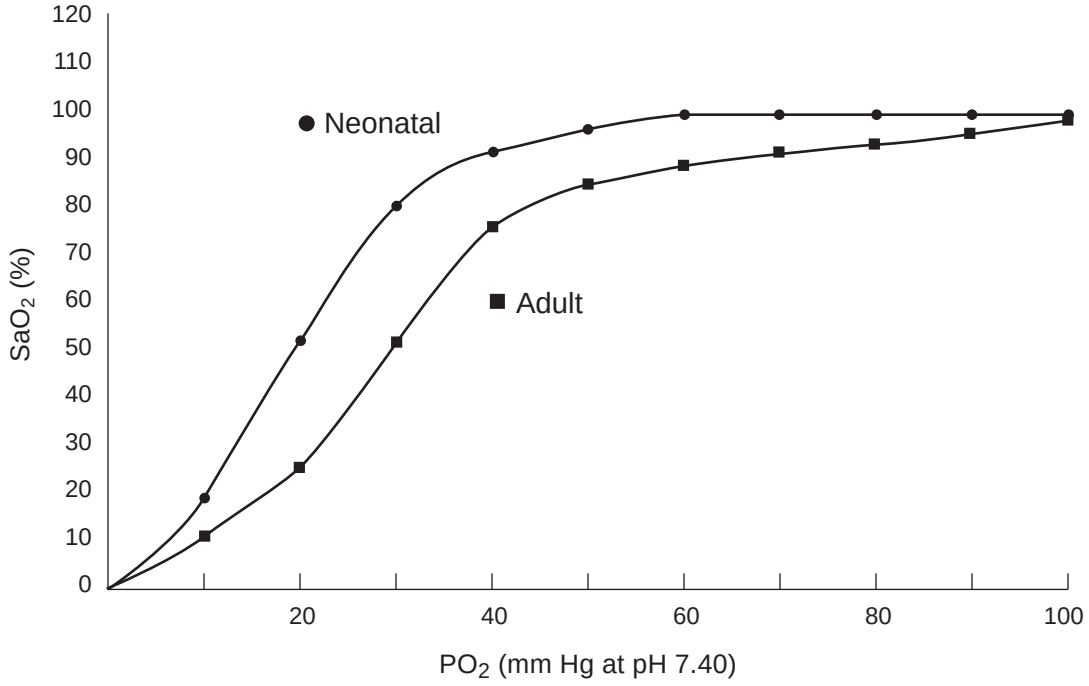
General Rules for Oxygen Management

1. Oxygen is a drug. Therefore its administration must be monitored, controlled, and measured to prevent complications.
2. Oxygen toxicity contributes to bronchopulmonary dysplasia and retinopathy of prematurity.
3. A small change in oxygen saturation may reflect a large change in arterial PaO_2.
4. The desired range for PaO_2 is between 50-80 mm Hg to maintain oxygen saturation between 90-95%.
5. For infants in room air, the O_2 saturation monitor upper alarm limit should be set at 100%.
6. O_2 saturation values should be assessed and documented.

Table 6.3. Acceptable indicators of Blood Gases

Indicators (mm Hg)	Arterial Blood Gas		Capillary Blood Gas
	28-40 weeks	< 28 weeks	
1 pH	7.30	> 7.28	7.33 – 7.40
2 PaO2	50 – 70 mm Hg	45 – 65 mm Hg	38 – 42 mm Hg
3 PaCO2	40 – 50 mm Hg	40 – 50 mm Hg	45 – 55 mm Hg.
Saturation	90-95%		

Figure 6.2 Adult and Fetal Hemoglobin Saturation Curves



The oxyhemoglobin saturation curves in adult and neonatal hemoglobin: approximate correlation between SpO_2 and PaO_2 while pH is 7.40 and temperature is 37^0 Centigrade.

6.2.5. Assessment of Respiratory Distress Severity

Table 6.4. Downe's Scale for Respiratory Distress Assessment

Parameters	0	1	2
Respiration rate	60	60-80	Over 80
Cyanosis	Absent	Room air breathing	Breathing 40% oxygen
Nasal flaring	Absent	Slightly noticeable	Moderate or expressed
Difficult expirations (grunt)	Absent	Could be heard during auscultation	Could be heard without a stethoscope
Auscultation	Breathing is clearly heard	Delayed or decreased	Breathing is barely audible

Assessment of the respiratory distress severity: 1. Score 3 or less – minimal respiratory distress

2. Score 4-5 – moderate respiratory distress 3. Score 6 or more – severe respiratory distress

6.2.6. Planned actions depending on the severity of the respiratory distress

1. Monitoring chart is created for each baby in the Neonatal department. Hourly assessment of the severity of the respiratory distress using the Downe's Scale is required. If the baby's condition worsens, then an assessment should be done when each new symptom appears.
2. Minimal respiratory distress (Downe's score of 2-3): actions could be limited to oxygen delivery to the incubator or via the facemask at the rate of 1-2 liters per minute. This would increase oxygen content in the airways up to 25-30%. If there is no positive effect, oxygen is given through nasal cannulas or CPAP.
3. Moderate respiratory distress (score 4-6): oxygen is given at the rate of 2-4 liters per minute via an oxygen hood or a tightly put facial mask, for newborns under 1250 gm. CPAP is through nasal cannulas or intubation tubes. In general infants who weigh less than 1250 g are often candidates for ventilation. However, all infants may receive oxygen via nasal CPAP (NCPAP) or through endotracheal tubes. Indication for providing NCPAP to newborns is when the PaO_2 in arterial blood is <60 mm Hg or a SpO_2 i.e. transcutaneous O_2 saturation of < 90%, when the oxygen concentration is 60%. **Please note that with regards to PaO_2, there is no correlation between arterial and capillary blood.** At this point, level 1 and 2 medical institutions should decide to transfer infant for a higher level of treatment. The formal process is based on the attached protocol of a telephone consultation.
4. Severe RDS: ventilation should be started through an endotracheal tube and respirator. If the respirator is not available then it should be performed manually with an AMBU bag until a resuscitation team arrives.

6.2.7. Oxygen therapy

Objective: provision of adequate oxygen to maintain tissue oxygenation

Methods: oxygen can be delivered to a newborn in an incubator by using oxygen masks, nasal cannulas and NCPAP or directly into the incubator

Requirements for oxygen therapy: oxygen should be warm and humid to avoid additional cooling and fluid losses. The oxygen saturation is 90-95% in order to achieve acceptable levels of PaO_2 (range 50-80 mm Hg in arterial blood in the majority of cases). If there is a need to use >40-60% O_2 and respiratory problems continue, more intensive respiratory therapy (CPAP, pulmonary ventilation) is required. Changes in the oxygen therapy should be assessed no less than every 30 minutes. Infant's continuous monitoring by physician/nurse should be conducted after the therapy is changed or if there are no visible clinical changes after the oxygen saturation is increased.

Oxygen therapy in an oxygen hood

Indications: It is indicated for mild RDS (assessment by Downe's Scale: score 2-4) or continuation of oxygen therapy after weaning from CPAP or pulmonary ventilation.

Equipment: oxygen supply, connecting tubes, oxygen hood with a thermometer, humidifier, rotary dosimeter.

Methods of the oxygen therapy via an oxygen hood:

1. The baby should be in an incubator or heated bed before the therapy is started.
2. The humidifier is turned on. The temperature is set for 32-34.5^{0}C and the humidity level for 70-80%. Oxygen is given at the rate of 2 liters per minute.
3. Oxygen delivery rate can be increased if necessary. If oxygen saturation falls below 90%, with an FiO_2 of > 60%, NCPAP is indicated.

Spontaneous breathing with continuous positive pressure in the airways (CPAP)

Indications: NCPAP is indicated for moderate RDS (Downe's score 4-6) or ineffectiveness of the oxygen therapy in hood (PaO_2 lower than 60 mm Hg or the SpO_2 is below 90% when the O_2 concentration is 60% or more).

Equipment: oxygen supply, connecting tubes, oxygen hood with a thermometer, humidifier, rotary dosimeter, water bath, gastric tube, mesh bandage or bandage for fixation of nasal cannules, and

intranasal cannules of the following sizes:

Table 6.5. Body weight/Cannula size ratio

Body weight (grams)	Cannula size
Lower than 700	0
700-1,250	1
1,250-2,000	2
2,000-3,000	3
Over 3,000	4

NCPAP Application

1. Suction mucus from the upper airway and stomach
2. Insert cannula into the nares
3. Fix the cannula on the patient's head
4. Connect to the CPAP system or a respirator with parameters set in advance
5. Insert an orogastric tube and fix it with a piece of tape

Application of Spontaneous breathing with positive pressure in the airways through the endotracheal tube (ETCPAP)

1. Conduct tracheal intubation
2. Connect to the CPAP system or a respirator with parameters set in advance
3. Insert an orogastric tube and fix it by a piece of tape

Supportive General principles of CPAP

1. Air-oxygen mixture should be humid and heated.
   1.1 The mixture temperature should be in the range 32-34.5^{0}C and humidity 70-80% for NCPAP.
   1.2 The mixture temperature should be in the range 36.5-37^{0}C and humidity 95-100% (see ETCPAP).
2. CPAP is started with a pressure of 4 cm H_2O and 50-60% O_2 concentration, which is given at the rate of not less than 3 liters per minute.
3. The pressure is increased by 1-2 centimeters up to maximum of 8 cm if hypoxemia persists 15-30 minutes after the beginning of the therapy.
4. Mechanical ventilation with a transfer for a higher level of treatment is indicated if hypoxemia persists 30 minutes after the pressure of 6 cm H_2O is reached and the SpO2 is below 92% or there is increasing hypercapnia ($PaCO_2$ is over 50 mm Hg and acidosis (pH is lower than 7.2).
5. If hypoxemia resolves, the oxygen concentration in the air-oxygen mixture is reduced to 40% (5-10% at a time), and then CPAP is gradually reduced (1-2 cm H_2O at a time).
6. CPAP is discontinued when the pressure is + 2 cm H_2O and the oxygen concentration is lower than 40%. Oxygen therapy is continued in an oxygen hood, where the oxygen concentration in the air-oxygen mix is 5-10% higher than for CPAP.

Indications for Mechanical Ventilation

1. Clinical Criteria:

- Apnea with bradycardia and cyanosis
- O_2 requirement >50-60% on NCPAP or significant respiratory distress on NCPAP
- Cyanosis not resolved by oxygen therapy alone
- Severe retractions/gasping respirations
- Hypotension, pallor and reduced peripheral perfusion
- Prolonged or severe bradycardia

2. Laboratory Criteria:

- $PaCO_2$ > 60 mm Hg
- PaO_2 < 50 mm Hg in 100% oxygen and CPAP
- pH < 7.25, due to respiratory acidosis
- Chest x-ray shows significant progressive deterioration

Note: Clinical symptoms and risk of complications are the leading criteria and not $PaCO_2$ and PaO_2 values.

Objectives of Mechanical Ventilation

Goal is to ensure adequacy of oxygenation and ventilation using the lowest possible ventilator settings, thus reducing barotrauma and oxygen-induced airway injury.

Arterial Blood gas (normal value)

PaO_2	50 -70 mm Hg (saturation 94-96%)
$PaCO_2$	38 - 45 mm Hg
pH	7.35 - 7.45

Capillary Blood gas (normal perfusion)

PaO_2	38 - 42 mm Hg (saturation 94-96%)
$PaCO_2$	40 - 48 mm Hg
pH	7.33 - 7.40

In long-term ventilated infants a higher $PaCO_2$ (~ 60-65 torr) is acceptable if the pH is normal.

In very tiny infants it is sometimes acceptable to have a lower PaO_2 (~45 torr) and a higher $PaCO_2$ (50-60 torr) if the pH stays above 7.28.

Note: Prior to initial attachment to the ventilator, it is not uncommon practice to ventilate the patient with a bag with manometer, and observe the actual pressures required to adequately ventilate the baby. Monitoring color, breath sounds, chest expansion, and respiratory effort will also help to determine if any changes are to be made on the ventilator set-up. Bag ventilation at different rates may help to determine the rate with which the newborn synchronizes best.

Ventilator Adjustments

- If $PaCO_2$ is elevated, rule out air leak, blocked ET tube and atelectasis, then increase PIP or Rate
- If PaO_2 is low - one may increase FiO_2, PEEP and/or PIP and lastly I-time

Frequency of Blood Gas Measurement

- Varies with type of disease and it's progression
- If unstable, more often; if stable, less often
- For markedly abnormal gas, change settings and repeat blood gas soon
- Remember, one may reduce Fio_2 based on pulse oximeter

Table 6.6. Initial Orders for Ventilation Set-up

Indicator		Newborns without pulmonary pathology	Newborns with RDS
1	PIP	12-18 cm H_2O	18-20 cm H_2O
2	PEEP	2-3 cm H_2O	4-5 cm H_2O
3	Frequency	10-20/min	20-40/min
4	I:E Ratio	1/2 to 1/10	1/1 to 1/3
5	Inspiratory time	0.3-0.5 sec	0.3-0.5 sec
6	Flow rate:	6-8 L/min for infants with birth weight less than 1000 grams 8-12 L/min for infants with birth weight more than1000 grams	

Weaning

Try to wean the most injurious parameter first. A guideline that may be used is to:

- Reduce PIP before PEEP
- High PIP before O_2 and Rate
- High O_2 before Moderate PIP
- In patients with lung disease one may extubate to NCPAP from low IMV of 5-10/min and if no lung disease present to Room air/O_2 by hood
- Provide at least 5% more O_2 than when patient was on ventilator
- In VLBW infants do not wean to ETCPAP prior to extubation. Extubate from IMV of 10

Complications of Ventilation

1. Early complications of ventilation
   - Pulmonary Air leaks - pneumothorax, pneumomediastinum, pulmonary interstitial emphysema
   - Tracheal intubation complications (tracheal and laryngeal rupture, vocal cords abruption, obstructions)
2. Late complications of ventilation
   - Pulmonary Air leaks - pneumothorax, pneumomediastinum, pulmonary interstitial emphysema
   - Endotracheal Tube complications - displacement, dislodgement, occlusion, atelectasis after extubation, palatal grooves
   - Tracheal lesions - erosion, granuloma, subglottic stenosis, necrotizing tracheobronchitis
   - Infection - pneumonia, septicemia
   - Impaired cardiac function
   - Chronic lung disease - Bronchopulmonary dysplasia
   - Intracranial hemorrhage, Patent ductus arteriosus, Retinopathy of newborns

Table 6.7. Correlation between Arterial and Capillary Blood Gases (ABG/CBG)

Indicators (mm Hg)		Arterial Blood Gas	Capillary Blood Gas
1	PO_2	50-70 (saturation 90 -95%)	38-42
2	pCO_2	38-45	40-48
3	pH	7.35-7.45	7.33-7.4
	Saturation	90-95%	

6.2.8. Infusion Therapy

Infusion therapy is indicated when there is difficulty in adequately feeding the infant and maintaining appropriate water balance.

Indications

- Requirements for hemodynamics normalization
- Maintenance of water and electrolyte balance
- Requirements for drug therapy
- Requirements for parenteral feeding

Venous access should be chosen in accordance with the infusion therapy indications. If access to a peripheral vein is not adequate, central venous catheterization should be chosen. It may be the umbilical or subclavian vein. In this case, a specialist of a mobile neonatal team should perform subclavian venous catheterization. A neonatologist in the maternity hospital can place an umbilical catheter. This should then be the preferred method so an IV line is immediately placed rather than waiting for a consultant to arrive.

The following procedure must be executed during umbilical venous catheterization:

1. Hand washing - surgical scrub
2. Clothing - sterile gown, facemask, and cap
3. Conditions are strictly aseptic
4. Sterile kit of instruments
5. Preparation of the surgical field
6. Stump fixation
7. Aseptic bandage on the umbilical stump and catheter hub

Calculation of Infusion Therapy

Term newborns need about 60-80 ml/kg/day of fluid on the first day of life. This quantity is increased by 10 ml/kg/day until it reaches 140 m/kg/day assuming the infant has been losing weight 1-3% per day. If there is no weight loss, fluids should not be increased. Fluid volume should be reduced to 60 ml/kg/day for asphyxiated babies. 5-10% glucose is satisfactory. Blood preparations and 5% albumin are indicated for hypovolemia and posthemorrhagic anemia.

For premature babies (especially for babies <1000 g), basal need is 80-120 ml/kg/day. 5% glucose solution is used, particularly for newborns with body weight < 1,500 grams. For premature babies with body weight of 500-700 grams up to the 2nd-3rd day of life, the need for fluids may reach 200-300 ml/kg/day because of large Insensible Water Losses (IWL) leading to dehydration and hypernatremia. Measures to control IWL can help to prevent the need for such large amounts of fluid.

Sodium, 2-4 mEq/kg/day if the gestation age is over 30 weeks and 3-5 mEq/kg/day if it is below 30 weeks, is a component of the infusion therapy. 2-4 mEq/kg/day of potassium, 2-4 mEq/kg/day of chlorides, 150 mg/kg/day of calcium (if necessary) are administered.

Note: Potassium should be administered IV in a solution not to exceed 1mEQ/1ml concentration. It must be diluted.

Glucose at 3-5 mg/kg/minute is prescribed for term babies and 4-6 mg/kg/minute for premature babies since this infusion rate is the physiological rate of utilization.

However, continuous monitoring of the blood glucose level is necessary. Blood glucose level in a neonate should not be less than 2.22 mmole/L (40 mg%). *Notes: Conversion factor for glucose indicator in mg/% to mmole/L is 0.0555. Therefore, 40 mg% equals to 2.22 mmole/L.*

Premature infants, those with growth retardation, asphyxiated babies as well as babies born to mothers who have diabetes mellitus are at risk of hypoglycemia.

The symptoms of hypoglycemia are hypotension, apnea, tremor, pallor, irritability, temperature instability, sleepiness, convulsions, cyanosis, and poor feeding.

Venous access should be provided and glucose infusion should be started. Bolus of 2ml/kg of 10% glucose solution followed by glucose infusion at a rate of 6-8mg/kg/min. Check blood glucose level every 15-30 minutes until the glucose level is stable.

Table 6.8. Neonatal demands for electrolytes

Electrolyte	Need (mEq/kg/day)	Need (mole/ kg/day)	Solution quantity (ml), containing 1 mole of the substance
Potassium	2-4	2-4	1 ml 7.5% of Potassium chloride solution contains 1 mole of Potassium and 1 mole of Chloride
Sodium			
over 30 GA weeks	2-4	3-5	1 ml 5% of Sodium chloride contains 1 mole of Sodium and 1 mole of Chloride
below 30 GA weeks	2-4	3-5	
Calcium (at the end of the first 24 hours of life)	0.45-0.9	0.22-0.45	1 ml 10% of Calcium chloride solution contains 1 mole of Calcium and 1 mole of Chloride
Chlorides	2-4	2-4	See above mentioned solutions

5% glucose solution should be used for the neonates with a body weight <1,500 gm. For babies weighing >1,500 gm, 10% glucose solution should be administered. Glucose infusion at the rate 4-6 mg/kg/min will assist to maintain normoglycemic condition (during the follow up transportation). However infants of poorly controlled diabetic mothers may need 8-10mg/kg/min (also during transportation).

Insensible Water Loss (IWL)

IWL includes radiation losses and losses due to evaporation through skin and airways. Term babies lose 35-40 ml/kg/day and premature babies lose 45-60 ml/kg/day.

Factors increasing IWL are extreme prematurity (50-100%), open heater (50-100%), phototherapy lamp (30-50%), hyperthermia (50-100%), and tachypnea (20-30%).

Factors reducing IWL in the incubator are humidification of the incubator (50-100%), plastic heat protector (30-50%), plastic cover under the heater (30-50%), and tracheal intubation with humidification (20-30%).

Assessment of fluid status

1. Cardiac rate hourly.
2. Close monitoring of urine output (by weighing diapers, pampers, urinal, etc. and in some instances by bladder catheterization), stool, and stomach contents. Urine volume is checked every 4 hours.
3. Daily weight (minimum twice daily) Daily weight loss of 1-3% is considered normal. Sometimes when the baby has edema, the weight loss of 15-20% (total over several days) should be considered acceptable if the baby remains stable, has adequate urination. Dehydration may be indicated by a daily loss of weight > 3-5%.
4. Sutures and fontanels – no retraction and protrusion, skull sutures should not be wide apart
5. Turgor of tissues is considered satisfactory if there is no loss of cutaneous turgor (skin elasticity)
6. Daily fluid intake should be monitored and include flush solutions and medications. Use of infusion pumps would be ideal. Hourly monitoring and documentation of the infused fluid volume is necessary. It should be corrected at least four times a day.

6.2.9. Antibacterial Therapy

Newborns in this group are at high risk of early postnatal sepsis development. Empirical antibacterial therapy is indicated for the majority of newborns with moderate and severe respiratory distress. Use one of the two following combinations: semi-synthetic penicillin with aminoglycosides or cephalosporins of the second generation with aminoglycosides. The decision regarding the duration and change of therapy should be made and will depend on the results of the microbiological control data, clinical, and biochemical blood tests.

6.2.10. Laboratory tests

Volume and number of lab tests is determined by the facilities available at the given medical institution.

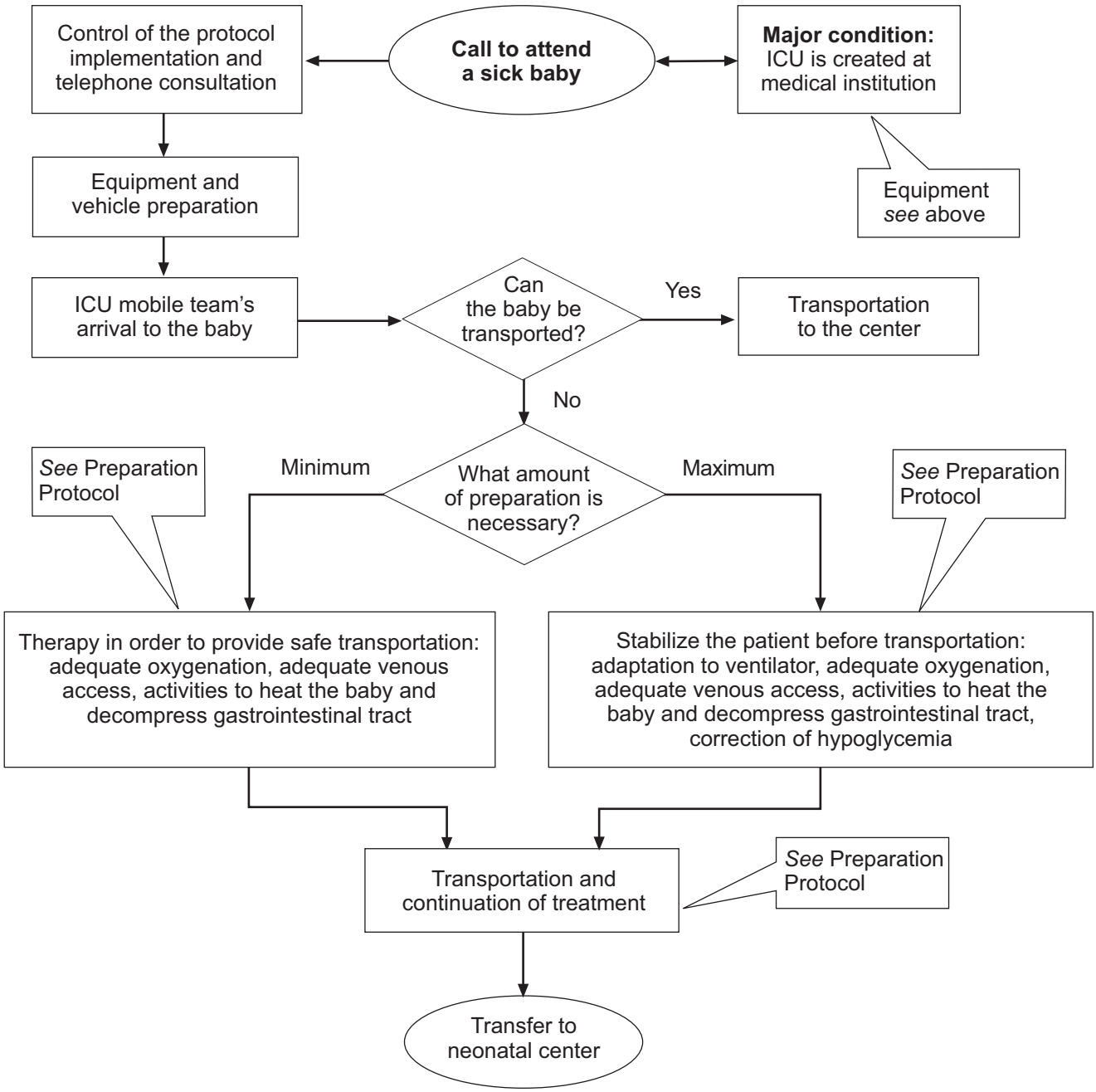
1. Complete blood count with platelet count is performed at admission. Bleeding duration and blood coagulation for severe cases. Repeat if indicated, as evidenced by bleeding.
2. Blood electrolytes should be done by micromethods - at admission and then if indicated
3. Blood glucose level once a day, in case of hypoglycemia – as often as required (every 30 minutes – 1 hour)
4. BUN, Creatinine, total protein on admission and when clinically indicated.
5. Urinalysis once a day, urine specific gravity, pH, microscopic test of sediment – at admission and than if condition gets more complicated
6. A major condition of laboratory tests is that the daily volume of blood taken for biochemical testing should not exceed 2% of the baby's circulating blood volume. Electrolytes and residual nitrogen daily during correction.

Note: Prior to initiating antibiotic therapy Blood cultures must be drawn.

6.3. Protocol of Neonate Transfer to a Higher Level of Treatment

This protocol should be performed for transferring babies from 1-2 level medical institutions to the Oblast neonatal center as well as prenatal mid-level referral centers.

6.3.1. Decision Making for Neonate Transfer: Flowchart for Transportation



6.3.2. Mobile ICU team

A mobile ICU team should include physicians and nurses. The team should be specially trained to provide care to newborns and in neonatal resuscitation. At the hospital from which it is necessary to transfer the newborn, the ICU team members will behave as

professional representatives of the neonatal center and avoid conflicts and criticism of the activities of the hospital personnel. The attending hospital physician together with the neonatologist from the neonatal center develops a transportation plan. Moreover, the team should benefit educationally from every visit to the medical institution.

Equipment: The mobile team should have the following equipment: vehicle, mobile incubator, ventilator, cardiorespiratory monitor with an electrode set, extra oxygen tanks, blood pressure measuring device with a set of cuffs, device to measure blood sugar level (glucotest), microperfusor, electrical thermometer, vacuum pump, and stethoscope. In addition, there should be a bag with supply materials and medications, which include the following:

Respiration maintenance: laryngoscope with a set of blades, endotracheal tubes of different diameters, stylet, catheters to suction mucus, gastric tube, catheters for oxygen supply, nasal cannulas for conducting CPAP, facial masks for newborns, AMBU bag, extra set of batteries for the laryngoscope and thermometer.

Provision of venous access: disposable syringes, needles, catheters for central and peripheral venous access, tape , scissors, sterile gloves, IV systems , tourniquet, alcohol, sterile bandaging material.

For heating the baby: caps, socks, mittens, warm diapers, warm blanket, heater.

Medications: Sterile solutions for infusion: 5, 10 %glucose, 4% sodium bicarbonate, 0.9% sodium chloride.

Medications in ampoules: adrenaline, 10% calcium chloride, medications from dopamine group, hydrocortisone, dexamethasone, deazepam, sodium oxybutarate, , promedol, lasix, antibiotics (initially ampicillin and gentamycin).

6.3.3. Recommendations Regarding Stabilization Of The Neonate's Condition and Transport

An objective of stabilization is the prevention of complications during transport and soon after.

General activities:

As a rule, the infant is prepared for transportation if its cardiac activity is normal. Transportation can be started when the infant's temperature is not lower than 36^0C, heart rate is 100-180 per minute, oxygen saturation is not lower than 90%.

The glucose level should not be lower than 2.22 mmole /L (40 mg%) with infused glucose taken into account.

Note: Conversion factor for glucose indicator in mg/% to mmole/L is 0.0555. Therefore, 40 mg% equals to 2.22 mmole/L.

The crucial moment is to evaluate the newborn's condition and to get patient's medical history. Vital organ functions should be assessed in order to conduct all necessary activities to stabilize the baby before transportation. Problems during transport should be assessed and all necessary adjustments should be made to prevent problems. It should be kept in mind that transportation, particularly a long one, could cause deterioration in the baby's condition. Appropriate steps should be taken to prevent the same. Even though the problem requires only an oxygen mask while the baby is at the hospital, CPAP or tracheal intubation should be initiated before transport. Venous catheterization should also be done. *All newborns with respiratory distress must be potentially considered to have pneumonia as a differential diagnosis until proven otherwise and should be given antibiotics as also those infants with intravenous catheters.*

6.3.4. Preconditions Before Transport

The 3 most important preconditions that should be met are

1. Correction of hypovolemia
2. Correction of hypoxia
3. Correction of hypoglycemia

Correction of Hypovolemia

Newborns delivered after abruptio placentae, problems with umbilical cord accidents, or maternal bleeding in the third trimester are at risk of developing hypovolemia and causing poor tissue perfusion.

Clinical signs of hypovolemia are continuous tachycardia, hypertension followed by hypotension, pallor, reduced urine output £1 ml/kg/hour, weak pulse, poor capillary refill and respiratory insufficiency without lungs lesions.

Treatment (restoration of the blood circulating volume and erythrocytes):

1. Use venous access of umbilical or subclavian catheter
2. For acute blood loss, it is necessary to use O negative blood
3. Blood substitutes – sodium chloride solution 0.9% or 5% albumin solution - 10 ml/kg
4. Continuous monitoring of arterial blood pressure is necessary

Correction of Hypoxia

1. Assemble a sterile respiration system
2. Ensure all connections are tight
3. Pour distilled water into the humidifier
4. Turn on the humidifier in advance so that by the time the newborn is attached to it, the air temperature is 36-37^{0}C
5. Adjust initial ventilator settings with a simulator for 50 ml
6. Oxygen concentration – 50-60%
7. Air-oxygen flow at the rate of 5-6 l/min
   - 7.1. Inspiratory time - 0.4 –0.6 seconds
   - 7.2. Expiratory time- 0.6 – 0.8 seconds
8. Respiration rate 40 – 60 breaths per minute
   - 8.1. Inspiratory/expiratory time ratio 1:1.5
   - 8.2. Peak pressure 20-25 cm H_2O
   - 8.3. Positive end-expiratory pressure + 4 cm H_2O
9. Once a neonate is hooked on to the respirator, a satisfactory chest expansion and synchronization with the respirator operation should be promptly provided for. The start settings for RDS are PIP of 18-20, PEEP of 4-5 and rate 60/min, oxygen concentration 100%. A blood gas should be obtained within 30 minutes. In case of unsatisfactory expansion, the PIP should be increased by 1-2 cm H_2O after several breaths until the expansion is satisfactory. If the expansion appears to be excessive, PIP should be decreased by 1-2 cm H_2O every few breaths until its amplitude appears optimal. Threshold limit values: maximal - 35 to 40 cm H_2O, and minimal - 14 to 16 cm H_2O.

Note: Most infants can be ventilated using PIPs/ PEEPs of 18-25/4-6.

10. If the infant remains cyanotic or the oxygen saturation level is under 90%, the oxygen concentration can be increased every few minutes by 5-10% until the infant is pink or the saturation readings are within acceptable range. If in a few minutes of mechanical ventilation, the saturation exceeds 96%, it should be necessary to gradually reduce oxygen concentration by 5% increments until the saturation value reaches the level of 90-96%.
11. Synchronization with mechanical ventilation should be carried out if an infant demonstrates resistance to mechanical ventilation. If the synchronization can not be achieved by selection of ventilation parameters.
    - 11.1 Achieve synchronization in patient by giving repeated doses of Diazepam supplemented with sodium oxybutirate. Doses:
      Diazepam – 0.5 mg/kg;
      Sodium oxybuterate – 50-100 mg/kg
    - 11.2 Attempt synchronization by giving narcotic analgesics (Promedole and Fentanyl). Doses:
      Promedole – 0.1 mg/kg;
      Fentanyl – 2-3 μg/kg
    - 11.3 Use myorelaxation drugs in case of emergency only.

Table 6.9. Ventilation Parameters, Air Oxygen Mix Concentration

Oxygen concentration percent	Maximum Peak pressure for birth weight< 1500 g	Maximum Peak pressure for birth weight> 1500 g	Maximum PEEP, cm H_2O	Respiration rate per minute
100	30-35	35-40	8**	60
90	28-30	30	7**	60
80	28	30	6	60
70	25	28	5	55
60	23	25	5	55
50	20	22	4	50
40	18	20	3-4	30-40
30	16	18-20	2-3	10-30

***Maximum PEEP should not exceed 6 cm H_2O when surfactant is used. PEEP of 7-8 cm H_2O may be needed before the introduction of surfactant. The pressures noted here are the highest that may be necessary to obtain a satisfactory blood gas, but most times lower pressures will suffice.*

Treatment of Hypothermia

Maintain the air temperature 1-1.5 degrees higher than the baby's temperature. In this case, oxygen consumption is minimal. **Very slow warming** may lead to increased risk of the continuation of physical consequences of hypothermia and a decrease in the glycogen reserve and hypoglycemia. However, **warming too rapidly** can cause apnea and hypotension. Therefore, it is recommended to perform warming slowly, i.e. 1°/hour.

Additional activities aimed at normal temperature maintenance:

1. Outside heat source
2. Careful drying of the baby
3. Cap, diapers, warm mattress
4. If stable, the baby can be placed next to the mother's skin and covered with a blanket
5. Avoidance of unnecessary unwrapping
6. Delay of the first bath
7. Warm, humidified oxygen

Correction of Hypoglycemia

Mobile team members must check blood glucose level and perform correction of hypoglycemia if necessary (Refer to 6.2.8 Correction of hypoglycemia in neonatal department).

Transportation of neonates with additional diseases

If the newborn has a pathology of the gastrointestinal tract (including congenital anatomic obstruction) or is on positive pressure via NCPAP or a face mask, then naso/orogastric tube for constant decompression of the gastrointestinal tract is indicated.

If there is suspicion that the patient has a tracheoesophageal fistula along with esophageal atresia, it is necessary to continuously aspirate the blind esophageal pouch during transportation. Newborns with suspected pathology of that kind should be transported with ET tubes (however, note that ventilation may not be necessary) and continuous sanitation of the gastrointestinal tract.

Mechanical ventilation with narcotic analgesic anesthesia should be used during transportation if diaphragmatic hernia is suspected. The head end of the bed is elevated 25-30 ° (Trendelenberg).

For newborns with skin defects (omphalocele, thermal burns) a warm moist bandage is put on the damaged skin to avoid heat losses and further covered with sterile film. Infants with developmental defects and burn injury require higher volumes of infusion therapy because of hypovolemia, additional third space losses and evaporation from damaged areas.

6.3.5. Transportation

The time of the infant's expected arrival at the neonatal center should be called in to the center. Parents may see and touch the baby before transportation.

Continuous monitoring during the transportation can identify sudden changes in the baby's condition. Respiration, heart rate, blood pressure, and oxygen saturation should be monitored. Therapy, started at the hospital as per an established program, should be continued during the transportation . Vital signs and completion of the tasks should be documented in the baby's monitoring chart. The time of the ICU team's arrival to the hospital and the beginning of the transport as well as the return to the neonatal center should be registered. As soon as the baby arrives at the center, the following cultures are performed: blood, urine, eyes, ears, and endotracheal tube.

The team should inform the parents and the physician at the hospital from where the baby was transferred (if possible) about the safe arrival of the infant at the referral center and its condition during and after the transportation.

Quality assessment of the transportation

Each aspect of transport should be given a score thereby assessing the infant's condition before and after the transportation . For instance, vital signs, body temperature, blood sugar level at the moment of the team's arrival to the hospital should be compared with similar indicators at the neonatal center. This type of assessment assures transportation quality and provides feedback to facilitate training of personnel working at the assigned hospitals.

6.4. Protocol of Neonatal Management at Neonatal Center

6.4.1. Treatment of Respiratory Distress Syndrome

Compensation of respiratory insufficiency is a major objective.

General Rules

General rules are equal both for maternity hospital Neonatal department protocol and for neonatal center.

Blood gas optimal values should be as follows: (arterial)

- PaO_2 – 50-80 mm Hg
- $PaCO_2$ – 35-48 mm Hg
- SaO_2 – 90-95% (pulse oximeter)

Acceptable blood gas values are:

- PaO_2 – 50-60 mm Hg
- $PaCO_2$ – 45-55 mm Hg
- SaO_2 – 90-95% (pulse oximeter)
- pH – 7.3 to 7.35 if the acidosis is only respiratory in nature. If the acidosis is metabolic in nature, it should be corrected with Sodium Bicarbonate.

Adjustment of mechanical ventilation in a patient with RDS

1. $PaCO_2$ above 50 mm Hg – suggests hypoventilation. Increase respiration rate by 5-8 breaths per minute if pH is < 7.3. Increase PIP by 2 cm H_2O. Repeat blood gas and acid base balance.
2. $PaCO_2$ 35-45 mm Hg – normoventilation. Decrease PIP by 1-2 cm H_2O. Repeat blood gas and acid base balance. If PIP is already at 16-18 mm H_2O, reduce respiratory rate by 5-10 breaths/min.
3. $PaCO_2$ below 35 mm Hg – hyperventilation. Decrease PIP by 2 cm H_2O or if already low reduce respiratory rate and repeat blood gas and acid base balance in 20 minutes.

4. $PaCO_2$ 46-50 mm Hg – acceptable in case of RDS. Keep settings unchanged. Repeat blood gas in 1-2 hours.
5. PaO_2 below 50 mm Hg – hypoxemia. Increase PEEP by 1-2 cm H_2O. Increase % O_2 by 5-10% /min. Repeat blood gas and acid base balance in 20 minutes unless a saturation monitor is available. Oxygen adjustments can for the most part be made using the saturation monitor.
6. PaO_2 50-80 mm Hg – normal in case of RDS. Keep settings unchanged. Repeat blood gas in another 1-2 hours.
7. PaO_2 above 80 mm Hg – hyperoxia. Decrease $\%O_2$ by 5% until oxygen concentration in term or pre-term infants is as close to room air as possible. Decrease alternately oxygen concentration by 5% and PEEP – by 1-2 cm H_2O. Repeat blood gas and acid base balance in 20 minutes after each setting is changed.

Correction of Acid-base imbalance

Acid-base imbalance can accompany respiratory distress without respiratory disturbances. It is also common in newborns with low Apgar score, hypovolemia, infection, or cardiac dysfunction. The criteria of the abnormality are pH <7.35 for the normal level of $PaCO_2$ (40-45 mm Hg) and base deficiency (BE) > -5, -6, -7, etc.

Treatment: Infuse 2 mEq/kg of sodium bicarbonate (4.2% solution- 4ml/kg) after the following conditions are met:

1. Provision of adequate ventilation
2. In case of hypovolemia - Adequate filling of the vessels
3. Hyperosmolar and concentrated solutions should be administered very carefully since it can lead to considerable redistribution of fluids in different parts of the body and increase the possibility of intracranial hemorrhage, ulceronicrotizing enterocolitis.

Airways management during mechanical ventilation:

- Adequate heating and humidification of the air-oxygen mix
- Drainage positioning of a neonate
- Percussion and vibration massage of the chest
- Endotracheal tube handling- under strict aseptic conditions and using sterile material only
- Infant's body position should be changed every 4-6 hours

Gradual transition to spontaneous respiration within 2-3 days is usually achieved by reducing the number of ventilations until it becomes equal to 5-10 per minute or transferring to auxiliary ventilation (rotating with spontaneous breathing).

At this stage:

- Disconnect mechanical ventilation, conduct CPAP through an endotracheal tube
- If the patient remains stable within several hours extubate a patient by disconnecting mechanical ventilation, then conduct CPAP through nasal cannulas
- Extubate and release a 100% oxygen flow through nasal cannulas 2 liters per minute

The choice of method depends on the patient's condition, disease gravity, ventilation duration and respiratory system condition.

6.4.2. Infusion Therapy

For as long as a neonate is in a serious condition, it is preferable to administer drugs intravenously. Moreover, intravenous infusions should be administered in a uniform manner for 24 hours. For this purpose, one should use peripheral veins of the extremities and the head, and with decreased arterial pressure(dopamine (dobutamine) administration), shock and the need for parenteral feeding, central venous catheterization via peripheral veins or subclavian/jugular venous catheterization should be conducted.

The total amount of fluids given should include all intravenous infusions, fats and drugs/flush solutions, colloids. Blood and blood substitutes should not be included in fluid goal calculations.

Tab. 6.10. Requirement for Fluids in the Normal Neonates Placed Inside An Incubator (ml/kg)

Age	Birth weight, grams 750-1000	1000-1250	1250-1500	1500-2000	Over 2000
1 day	80	80	80	60	60
2 days	90	90	90	80	80
3 days	100	100	100	100	100
4-7 days	110-140	10-140	110-140	110-140	110-140
2-4 weeks	150-160	140-150	140-160	140-160	140-160

In addition to maintaining proper water balance in the neonate, by the end of its first day of life the calcium level should be controlled (daily calcium intake should be 0.45-0.9 mEq/kg or 0.22-0.45 mmole/kg/day). Starting from day 2-3 if there are no pathological losses such as vomiting, gastrointestinal discharge, or sequestration into gastrointestinal tract, a potassium supplement should be administered in the amount of 1-2 mEq/kg/day (1-2 mmole/kg/day) or 2-3 mEq/kg/day (2-3 mmole/kg/day) in pre-term infants, as well as a sodium supplement in the amount of 2-3 mEq/kg/day (2-3 mmole/kg/day).

In case of central hemodynamics disorder, shocks, symptoms of microcirculation disorder dopamine should be indicated.

Use of Dopamine

Initiate dopamine in the amount of 3-5 μg/kg/min if necessary to support blood pressure, and when there is concomitant cardiac pathology or diaphragmatic hernia – up to 10-20 μg/kg/min. The object is to maintain a good mean arterial pressure of at least 5-10 mm Hg higher than normal to reduce right to left shunt. It should be noted that for hypotension the dosage may total to 40 μg/kg/min, however, if dopamine dosage of 20μg/kg/min is not effective, a parallel dobutamine dosage starting from 5 μg/kg/min should be indicated. Consider the therapeutic effect of the dopamine dosage:

- 3-5 μg/kg/min - aid in renal perfusion, decrease in total peripheral resistance, weak cardiotonic effect
- 5 μg/kg/min - distinct cardiotonic effect, increase in minute output because of the increase in cardiac rate, decrease in oxygen tissues consumption
- over 5 micrograms/kg/min - increase in total peripheral resistance, increase in cardiac rate, increase in system pressure, increase in oxygen tissues consumption, development of tissue acidosis.

Proper infusion therapy should include control of the following:

1. Solution Heparinization: Heparin should be added to all hyperalimentation solutions, as well as to all fluids administered through arterial and central venous lines. The presence of heparin may prolong the patency of both peripheral and central lines and promote a lower level of triglycerides. As a rule, the dose of heparin to be added equals to 50-100 Units per 100 ml solution.
2. Measure urine output every 4 hours. Urine output slightly higher than 1 ml/kg/hour should be a minimal acceptable level. 2 ml/kg/day should be considered adequate. If the urine output is over 4 ml/kg/day, consider reducing the intake.
3. Urine: specific gravity should be closely monitored as well. One should measure the specific gravity of each urine sample for decreased output and every other sample for normal urine output. Specific gravity of 1010-1016 should be considered normal. If a specific gravity is higher than 1018 and below 1008, the volume of the given fluids should be adjusted.

4. Increased levels of residual nitrogen, sodium or serum bilirubin may also be indicative of dehydration or inadequate fluid intake.
5. Objective data: skin turgor, saliva quality and quantity, airway secretions (not a concern if humidity is provided through the respirator), condition of the fontanel, skull sutures, CVP, tachycardia.
6. Weigh daily: The loss of birth weight by 1-3% per day to a maximum of 15% by day 4-5 of life should be considered as normal.
7. Sometimes the loss of birth weight by 15-20% should be treated as acceptable if the infant remains stable, and has an adequate urination and electrolyte level. Dehydration should mean a daily loss of weight in the range 3-5%.
8. Efforts aimed at maintaining birth weight in the first 2 weeks of life and accompanied by lack of needed calories (70-90 cal/kg/day) should lead to over hydration and a hemodynamically significant ductus arteriosus.

As soon as the condition is stable, one may initiate a dosed enteral tube feeding of the infant after giving a sample amount of sterile water (starting with 0.5 ml an hour during the first 24 hours of feeding).

Presence of a significant amount of residual gastric contents, persistent regurgitation or bile-stained vomiting, hypoactive or hyperactive bowel, blood in the stool and peritoneum irritation symptoms should be considered as contraindications for starting enteral feeding.

Normalization of acid-base balance and the levels of bilirubin, creatinine and urea should be considered as an important prerequisite for total enteral nutrition.

6.4.3. Feeding the Infant

Before starting enteral feeding it is necessary to perform the following:

1. Abdomen examination should be started.

   If the following signs are present obtain an X-ray of the abdomen: abdominal distension, vomiting, firm abdomen, extensive peristalsis or absence of bowel sounds.
2. Meconium passage should be established.
3. Serum electrolytes should be normal.
4. Newborn has to be stable, even if he is intubated. An infant on muscle relaxants and dopamine should not be fed.
5. Respiratory rate should be lower than 60 breaths per minute during breast-feeding and not over 80 breaths per minute during tube feeding.

It is better to use maternal milk for the enteral feeding, if not available, adapted milk mixes for newborns should be used.

On average 100 ml of breast milk provide 69 kcal, 100 ml of colostrum ~150 kcal, and intermediary milk (from 4-5 days of lactation) ~ 70-75 kcal.

Energy needs of a newborn

1. To maintain a stable body weight - 60 kcal/kg/day.
2. To increase body weight by 15-30 g /day - 100-120 kcal/kg/day.
3. Ingredients needed: carbohydrate - 11-16 g/kg/day, protein – 2.25-3 g/kg/day, and fats - 4-6 g/kg/day.

6.4.4. Neonatal Parenteral Feeding

It is expected that baby will not be able to be fed normally in cases of congenital defects of the intestines, RDS, gastroschisis, meconium ileus, necrotizing enterocolitis, paralytic ileus, and extreme prematurity.

If feeding volume cannot be increased for several days, parenteral feeding should be indicated in addition to the enteral feeding.

It can be initiated as soon as water and electrolyte balance are stable usually on the second day for term and on the 3-4 day for premature infants.

Peripheral veins may be used for parenteral feeding. The injected glucose concentration should not exceed 12.5%. Central veins should be used if glucose concentration is increased to > 12.5%.

The infusion initial rate should be 6-8 mg/kg/min of glucose. The dose should be increased by 0.5-1.0 mg/kg/min each day, depending on daily needs and concentration of the injected solution.

The initial rate of amino acid infusion should be 1 g/kg/day for term newborns and 0.5 g/kg/day for newborns with a birth weight < 1,500 grams. The daily increase can be 1 g/kg/day for term and 0.5 g/kg/day for premature infants. Maximum amount should not exceed 3 g/kg/day.

Fats can be administered to newborns, except whose serum bilirubin level is over 170 μmole/L (term infant) and over 85 μmole/L (<1500 G). Usually, fat is administered 0.5 g/kg/day on the first day, 1 g/kg/day on the second, and 2 g/kg/day (maintenance dose) on the third day. Infusion rate should not exceed 0.5 gm/kg/hour. Fat must be administered at 0.5 g/k/day in all infants by 5-7 days irrespective of bilirubin level if the infant is not receiving any milk orally to prevent Essential Fatty Acid Deficiency (EFAD). Term infants may receive up to 4g/kg/day.

6.4.5. Laboratory Tests

1. Routine after blood gas indicators are stable and acid basic balance parameters are set pulse oximeter monitoring – 4 times a day blood is taken from a newborn's heel to measure blood gas and acid basic balance.
2. Clinical blood test with platelet count is performed. The bleeding times and blood coagulation is monitored when there is evidence of bleeding.
3. Blood electrolytes should be done by micromethods (once a day).
4. Blood glucose level twice a day, in case of hypoglycemia close monitor until stable. Then once every 6 hours.
5. BUN, creatinine, bilirubin, total protein, and protein fractions in case of edema (once a day)
6. Urinalysis once a day, urine specific gravity, pH, microscopic test of sediment.
7. Blood test for specific intrauterine infections (toxoplasmosis, CMV, syphilis, HBs-antigen, AIDS , etc.) when hospitalized. Bacteriological blood and urinalysis are performed at the time of hospitalization. Eye, nose, ear, feces cultures and cultures from the ET are taken when hospitalized and in case of symptoms of infection.
8. After intubation– central veins catheterization, chest X–ray and then routinely every 4–5 days. If there are increasing symptoms of hypoxia of progressing disease – chest X–ray at once.

6.4.6. Medication Therapy for Newborns with RDS

Table 6.11. Medication therapy for newborns with RDS

Medication	Dosage and Administration
Ampicillin	Age under 7 days: 200mg/Kg/24h divided into two doses given at 12 hour intervals Age above 7 days and weight up to 2Kg: 200mg/Kg/24h divided into three doses given at 8 hour intervals Age above 7 days and weight above 2Kg: 200mg/Kg/24h divided into four doses given at 6 hour intervals
Gentamycin	Age under 7 days: 2.5 mg/Kg/24h given in one dose Full term baby and above 7 days age: 6mg/Kg/24h divided into three doses given at 8 hour intervals
Claforan	Age under 7 days: 100mg/Kg/24h divided into two doses given at 12 hour intervals Age above 7 days: 150mg/Kg/24h divided into three doses given at 8 hour intervals
Cefazolin	Weight under 2Kg: 40mg/Kg/24h divided into two doses given at 12 hour intervals Weight above 2Kg and age under 7 days: 40mg/Kg/24h divided into two doses given at 12 hour intervals Weight above 2Kg and age above 7 days: 60mg/Kg/24h divided into three doses given at 8 hour intervals
Fortum (Ceftazidime)	Age under 4 weeks and weight under 1.2Kg, or age under 7 days and weight above 1.2-2Kg: 100mg/Kg/24h divided into two doses given at 12 hour intervals Age under 7 days and weight above 2Kg: 100mg/Kg/24h divided into three doses given at 8 hour intervals Age above 7 days and weight above 1.2Kg: 150mg/Kg/24h divided into three doses given at 8 hour intervals
Metrogyl	Age under 4 weeks and weight under 1.2Kg, or weight 1.2-2Kg and age under 7 days: 15mg/Kg loading dose. Wait for 48 hours after loading dose, then give 7.5mg/Kg/24h in one daily dose Weight 1.2-2Kg and age above 7 days, or weight above 2Kg and age under 7 days: 15mg/Kg/24h 24h divided into two doses given at 12 hour intervals Weight above 2Kg and age above 7 days: 30mg/Kg/24h divided into two doses given at 12 hour intervals
Dexamethasone	0.5-0.75mg/m^2 body surface area/24h
Euphyllin	5 mg initially, then 2-2.5mg/kg/24h divided into 2-3 doses given at 8-12 hour intervals
Diazepam	0.1-0.3 mg/Kg single dose

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Appendix 1

QAP Project

Protocol-abstracts from neonatal record

Mother's name _____

Father's name _____

Registration address _____

Actual address _____

Marriage _____ (#), registered (yes/no) _____

Mother lives: ❑ with the child's father ❑ alone ❑ with relatives

Admitted to the department at hour _____ min _____ date _____ year _____

Baby was born in 1OB department _____ 2 OB department _____ out of hospital _____

	Mother	Father		Mother	Father	Child
Age			Blood group			
Nationality			Rh-factor			
Profession			Signature			
Position						

Maternal heredity illnesses: _____

Maternal bad habits: ❑ Smoking ____ pack(s) a day. ❑ Alcohol _____ (daily average)
❑ Narcotics _____

OB history: Pregnancy _____ Delivery _____ (#)

Outcomes of previous pregnancies:
abortions _____ spontaneous abortion _____
earlier born children with developmental defects _____ perinatal death _____
health status of living children _____

Paternal health

Paternal heredity illnesses: _____

Paternal bad habits: ❑ Smoking ____ pack(s) a day. ❑ Alcohol _____ (daily average)
❑ Narcotics _____

Maternal health status

Pathologies	Before pregnancy	During pregnancy	In labor	Postpartum (at transfer of the baby)
Extragenital				
Gynecological				
Pregnancy induced				
Maternal treatment: • Antibiotics • Hormones				

Delivery

RDS prevention with steroids (yes/no) _____ duration _____ doses _____

Delivery: gestational age _____ weeks, spontaneous _____ induced _____

Duration: 1 period _____ 2 period _____ Anhydrous interval _____

Amniotic fluid: meconium _____ ,opaque, green, _____ blood stained, _____ bright, clean _____

Delivery peculiarities:

without pathology _____ powerless labor _____

labor stimulation _____ excitement _____

anatomic peculiarities of pelvis _____

cephalopelvic disproportion _____ bleeding _____

other pathology _____

Labor anesthesia _____

C-section:

Maternal indications _____

Fetal indications _____

Before labor _____ in labor _____

Obstetrical forceps _____ Vacuum-extraction _____

Hand placental separation _____ Others _____

Fetal status

Antenatal (Ultra sound examination, others).

Pathology not identified, estimated fetal weight _____

Intrauterine growth retardation, hypotrophy _____

Chronic fetal hypoxia _____ developmental defects _____

Intranatal period abnormalities: fetal presentation _____

complicated delivery _____ risk of asphyxia _____

asphyxia started: _____

Placental abnormalities: _____ umbilical cord _____

Newborn

Sex: male/female, which (in case of multiple pregnancy) _____

term _____ pre-term _____ over-term _____

	At birth	At transfer to another medical institution
Body weight		
Circumference of head		
Body length		
Circumference of chest		
Circumference of shoulders		
Weight/height ratio		

Apgar score assessment:

Minute	Heart	Respiration	Skin	Muscular tension	Reflexes	Total score
1st						
5th						
10th						

Prevention of Gonoblennorrhea	1	2	Signature
Time			
Drug			

Bursting of meconium: ❑ Yes Date _____ ❑ No

Large congenital anomalies: _____

Small congenital developmental anomalies _____

Risk of perinatal pathology

	At birth	At transportation	At treatment in the center
Respiratory problems			
Encephalopathy			
Infections			
Hemolytic disease of newborns			
Hemorrhagic complications			
Metabolic problems (hypoglycemia)			
Hypothermia			
Cardiac insufficiency			
Others:			

Neonatal status assessment at transfer from a delivery ward

External genitals	First breastfeeding (age/hour/where?)
Urination (time of the first urination)	Transfer to children department (time)
Presence of anus (at examination)	Transfer to ICU (time)
Bursting of meconium (time and frequency)	May stay with mother
Esophagus is patent at intubation (time)	Other notes

Volumes of primary and resuscitation neonatal care in a delivery ward

Age in minutes:	20s	40s	60s	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Spontaneous breathing:																						
absent irregular																						
regular																						
tachypnea (>60 /min)																						
Heart rate (HR):																						
absent																						
< 100 /min																						
≥100 /min																						
Umbilical cord pulsation																						
Arbitrary muscle movements																						
Skin color:																						
very pale																						
poured cyanosis																						
acrocyanosis																						
pink																						
Actions conducted																						
Warming by a radiant heater																						
Other ways of warming																						
Mucus suction from upper airways																						
Laryngoscopy																						
Tracheal intubation																						
Tracheal suction																						
discharge character																						
Oxygen via mask (%)																						
Ambu/Pentlon bag ventilation																						
air																						
oxygen (%)																						
Mechanical ventilation - settings:																						
PIP																						
PEEP																						
Tin																						
fr																						
Closed chest compression																						
Puncture / umbilical vein catheterization																						
Medication therapy:																						
Adrenaline solution 1:1 0000 via ETT I/V ml																						
Isotonic solution NaCl I/V																						
Na hydrocarbonate** 4%- solution I/V ml																						
Albumin 5% solution I/V ml																						
Other actions:																						

Neonatal status assessment

Date Time	Attending physician assessment	Team's doctor assessment	Assessment after transportation
Age			
General state			
Posture			
Cry			
Rectal temperature			
Skin: Pink/pale			
Cyanosis/acrocyanosis			
Petechiae in area			
Maceration, scaling, eruptions			
Edematic subcutaneous fat			
Generic tumor			
Hemorrhage			
Cephalhematoma			
Respiratory status: RR			
Breathing: normal			
Groaning			
Forced			
Nasal flaring			
Foamy discharge			
Mandibular retraction			
Chest inflation			
Chest retractions			
Weakening respiration			
Coarse bubbling			
Fine bubbling rale, crepitations			
Degree of respiratory insufficiency			
Cardiovascular system: HR			
Dull percussion sounds			
Cardiac sounds: accent/ dull			
Rhythm			
Murmurs: cardiac/ vascular			

continued on following page

Neonatal status assessment *(continued)*

	Attending physician assessment	Team's doctor assessment	Assessment after transportation
Nervous system: without pathology			
Cerebral activity			
Motor activity			
Muscular tension			
Reflexes: grasping			
Moro's			
Postural			
Tendon			
Tremor/clonus /seizures			
Pareses/ Paralyses			
Eye symptoms			
Diuresis			
Umbilical cord stump: norm			
Edema. Staining			
Hemorrhagic diathesis			
Digestive organs: sucking			
Regurgitation			
Stomach			
Liver			
Spleen			
Skeletal system: head			
Cranial suture			
Greater fontanelle			
Lesser fontanelle			
Clavicles			
Hip joint			
Baby's weight			
Document checked: physician of the MI where the child was born			
Physician in charge of transportation			
Physician in charge of receiving at the center			

Baby's examination data

Measurement	Date and time of examinations							
/day								
/hour								
Erythrocytes								
Hemoglobin								
Hematocrit								
Leucocytes								
Blood platelets								
Segmented neutrophils								
Neutrophils								
Lymphocytes								
Erythrocyte sedimentation rate (ESR)								
Bilirubin								
Sugar								
PO_2								
Weight dynamics by days								

Neonatal treatment

Medications	Treatment in Maternity hospital		Pre-transportation preparation	Treatment during transportation
Antibiotics	Starting dates		Changes in dose, Frequency	
Ampicillin				
Gentamicin				
Infusion therapy:	Volume/day		Volume	Volume
Blood preparation:	Volume/day		Volume	Volume
blood				
red blood mass				
plasma (what kind?)				
Respiratory therapy:	How many hours/days	% O_2		
oxygen therapy				
hood/mask				
NCPAP				
Ventilation				
Flow				
Frequency				
PIP				
PEEP				
I:E				
Other medications				
Sodium bicarbonate	Sodium bicarbonate		Sodium bicarbonate	Sodium bicarbonate

Initial diagnosis (made by attending physician of the referring hospital)

Appendix 2

Neonatal monitoring of adaptation period deviations. Date:

Time	9	10	11	12	13	14	15	16	I7	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	Examination and consultations
Downe's scale assessment																									
Respiratory rate																									
Spontaneous																									
Hood/mask																									
CPAP																									
Ventilation																									
O_2 flow																									
Frequency																									
PIP																									
PEEP																									
I:E																									
O_2 concentration (%)																									
Pulmonary auscultation																									
SaO_2																									
pO_2																									
pCO_2																									
Temperature																									
Heart rate																									
BP systolic																									
BP diastolic																									
BP mean																									
Nervous system activity																									
Phototherapy																									24 hours total
Drink																									
Feeding																									
Regurgitation																									
Diuresis																									
Stools																									

Signature of the physician: _____

Signature of the nurse : _____